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Innovative Solutions to Human–Wildlife Conflicts

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Wildlife Services

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Introduction

EEVB staff conducting experimental procedures in examining the utility of Nobuto strips for detecting West Nile virus in red-winged blackbirds in the BSL-3 laboratory at NWRC ***(Photo by Kevin Bentler)***

The mission of the National Wildlife Research Center (NWRC) is to apply scientific expertise to resolve human-wildlife conflicts while maintaining the quality of the environment shared with wildlife. As the research arm of the USDA Animal and Plant Health Inspection Service's (APHIS) Wildlife Services (WS) program, NWRC develops methods and information to address human-wildlife conflicts related to:

- agriculture (crops, livestock, aquaculture, and timber),
- human health and safety (wildlife disease, aviation),
- property damage,
- invasive species, and
- threatened and endangered species.

The NWRC employs more than 160 scientists, technicians, and support staff to develop and evaluate new wildlife damage management tools and strategies that are biologically sound, environmentally safe, and socially responsible. NWRC's research authority comes from the Animal Damage Control Act of 1931. This Act allows the Secretary of Agriculture to conduct investigations, experiments, and tests to determine the best methods of controlling animals injurious and/or a nuisance to agriculture, horticulture, forestry, animal husbandry, wildlife, and human health and safety. It also gives authority to the USDA to develop methods and control wildlife that are reservoirs of zoonotic diseases.

NWRC's research programs and priorities are based on nationwide research needs assessments, Congressional directives, WS program needs, and stakeholder input. The Center is committed to helping resolve the ever expanding and changing issues associated with wildlife damage management and remains well positioned to address new issues through proactive efforts and strategic planning activities.

NWRC research is organized under three research programs that reflect APHIS' commitment to "protecting agricultural and natural resources from agricultural animal and plant health threats, zoonotic diseases, invasive species, and wildlife conflicts and diseases"[1]:

- **Agriculture and Resource Protection**—Focuses on reducing wildlife damage to crops, aquaculture, timber resources, livestock and property; examines the ecology, behavior, and management of birds and mammals; and develops methods to mitigate wildlife-aviation strike hazards.

- **Invasive Species and Technology Development**—Develops methods for reducing damage by invasive vertebrate species to native wildlife and ecosystems; promotes technological development in areas related to pesticide registration, formulation chemistry, chemical analysis, benefit-cost analysis, and wildlife contraceptives.

- **Wildlife Disease**—Explores ways to reduce the spread and transmission of diseases from wildlife to humans and domestic animals; develops disease diagnostic methods; develops methods and strategies to monitor wildlife pathogens; assesses risks to agriculture and human health and safety; and assists WS operations with surveillance and monitoring.

[1] From *APHIS Strategic Plan (2007-2012)*

In addition to the three main research programs, the NWRC maintains a broad range of support functions, including pesticide and drug registration, analytical chemistry, animal care, administration, information transfer, archives, quality assurance, facility development, and legislative and public affairs.

Strategic Planning

In 2008, the NWRC Management Team and staff developed a new 5-year strategic plan for the Center. The NWRC Strategic Plan for 2008-2013 informs and provides guidance to NWRC employees, partners, and stakeholders regarding the Center's vision, mission, and long-term strategic goals. It identifies several key challenges NWRC management and employees face and aligns NWRC's goals with the APHIS mission and organizational priorities.

During 2008-2013, NWRC will strive to reach the following strategic goals:

- Strengthen research capacity
- Value and invest in NWRC employees
- Enhance animal well-being
- Improve information and technology transfer
- Develop and secure adequate workforce and infrastructure

Leadership Changes

NWRC Director Richard Bruggers Retires—After a long and very productive professional career, Dr. Richard Bruggers retired as Director of the NWRC in April 2008. Dr. Bruggers began his academic career with an undergraduate degree at Hope College in Holland, Michigan. Subsequently, he received both his master's and doctorate degrees in biology at Bowling Green State University (BGSU) in Ohio, where he studied animal behavior. Like many at NWRC, Dr. Bruggers gained his early professional experience as a field technician. In 1969, he worked as a fisheries technician for the Washington Department of Fisheries. He quickly moved into a career in animal control as a consultant while at BGSU, where he took jobs with the private pest control industry and did mosquito, rodent, and bird control work.

Dr. Richard Bruggers on far right. *(Photo by Gail Keirn, LPA)*

After receiving his doctorate in 1974, Dr. Bruggers spent 5 years as a bird control specialist with the United Nations Development Program. There, he led and participated in bird control and crop protection projects in both western and eastern African countries. This experience led Dr. Bruggers to the Denver Wildlife Research Center (DWRC) in 1979 (now the NWRC as of 1998), where he joined the Section of International Programs first as a wildlife biologist and then as Section Chief in 1984. During this time, Dr. Bruggers published more than 80 scientific papers and a book, *Quelea, Africa's Bird Pest* (Oxford University press). Over the years, Dr. Bruggers worked in 34 countries, while providing oversight for 110 assignments for NWRC scientists working in 95 countries. This was a period of critical importance for U.S. Government technical assistance to developing countries. The U.S. Agency for International Development, the World Bank, the international agriculture research centers, and several United Nations agencies all relied on the NWRC's research and technical expertise.

In 1994, Dr. Bruggers was selected as the Assistant Director of the DWRC/NWRC and, in 2004, as the Director of the NWRC. Dr. Bruggers worked a total of 5 years with the United Nations, 8 years with the U.S. Department of the Interior, and 22 years with USDA. He has had a long and illustrious 35-year career as a scientist who has made many important contributions to bird pest management, brown treesnake methods development, international capacity building, and the development and impact of the NWRC in the field of wildlife damage research. Some of Dr. Bruggers' notable contributions relate to the first studies to aerially mark birds; development of miniature transmitters for quealea in Africa; development of repellents; and behavioral ecology studies to mitigate bird damage to crops in Africa. Dr. Bruggers has also made invaluable contributions toward the development of the NWRC. He has developed and instituted the Center's current Research Project Management System; established (along with the Center's previous Director) the new NWRC headquarters in Fort Collins, providing Wildlife Services with state-of-the-art research facilities and Biosafety Level 3 (BSL-3) capabilities; initiated improved security measures to protect staff and other assets throughout the Center; and acquired a dedicated Legislative and Public Affairs Specialist for the Center.

Dr. Bruggers' own background in field research helped him recognize the need for modernizing the NWRC's Field Station facilities, and the Center accomplished much of this work during his tenure. Dr. Bruggers has fostered WS research and operational collaborations and closer relationships with universities, other APHIS programs, and other partners. In these endeavors, Dr. Bruggers has worked tirelessly to garner stakeholder and financial support for research and methods development activities at NWRC.

Dr. Bruggers' contributions to the wildlife services field have been recognized with one USFWS Group Achievement Research Award, six DWRC/NWRC scientific publication awards, an Accomplished Graduate recognition award at BGSU, USDA and APHIS International Honor Awards, a Jack H. Berryman Institute Award, a Wildlife Services Deputy Administrator's Strategic Vision and Strategic Management Award, a nomination for the Presidential End Hunger Award, and two USDA Honor Awards (the highest recognition within USDA). Dr. Bruggers was also an elected Fellow of The Explorers Club, a prestigious international professional society dedicated to the advancement of field research and scientific exploration.

New NWRC Director and Assistant Director—Dr. Larry Clark was named as the new Director of the NWRC in April 2008. Prior to this position, Dr. Clark served as the Center's Assistant Director and was responsible for managing the NWRC and its field stations, setting internal policies and directives, and promoting collaboration among research programs.

Dr. Larry Clark.
(Photo by Gail Keirn)

Dr. Clark received his Ph.D. in Biology from the University of Pennsylvania and began his career with APHIS in 1991. During the past 17 years, he has been instrumental in establishing NWRC's wildlife disease research capabilities and has held positions as both an APHIS science fellow and research scientist. In 1995, Clark became one of the first NWRC staff members to establish a cooperative relationship with the Colorado State University community.

Dr. Mark Tobin.
(Photo by Gail Keirn)

Dr. Mark Tobin was selected as the new Assistant Director to fill Dr. Clark's vacant position in August 2008. Dr. Tobin was the Agriculture and Resource Protection Program Manager before becoming Assistant Director. In his 20-year career with NWRC, Dr. Tobin has served as Supervisory Research Wildlife Biologist at the Hilo, Hawaii, and Starkville, Mississippi, field stations. His research has included developing tools and methods to control aquaculture bird depredation and rodent damage in Hawaii. He received his Ph.D. in Ecology from the University of California, Davis.

Construction Update

NWRC's 43-acre headquarters campus is located on the Foothills Research Campus of Colorado State University in Fort Collins, Colorado. As part of the Master Plan for the NWRC site, several planning and construction activities took place during fiscal year (FY) 2008.

Guard House and Guard Stand—A new Guard House and Guard Stand to further enhance the security capabilities of the NWRC site was completed in July 2008. The new Guard House and Guard Stand are located just outside the main entrance to the NWRC site and provide facilities for the Center's security guard service to better provide surveillance and monitoring of all vehicular traffic entering and exiting the NWRC site. The enhanced security helps the Center to meet the higher level security requirements for the BSL–3 biocontainment research suite that opened this year in the existing Animal Research Building and the future Wildlife Disease Research Building (WDRB) BSL–3 Ag biocontainment research building (described below).

Acoustic Attenuation of the Invasive Species Research Building—A building exhaust acoustical attenuation construction project was completed on the existing Invasive Species Research Building (ISRB) in August 2008. The purpose was to reduce the sound generated by the massive amount of exhaust air that is eliminated continuously from the air exhaust stacks located on top of this indoor animal research building. The ISRB provides a state-of-the-art facility to properly care for and study invasive wildlife. Rooms in the building are designed to simulate temperature and humidity ranges from temperate to tropical ecosystems. The lack of recirculated air in the ISRB leads to the tremendous amount of exhaust air being eliminated through the stacks. New acoustic attenuators in lengthened exhaust stacks have reduced the noise to more acceptable levels for both humans and animals.

Wildlife Disease Research Building—WS is working to construct a new BSL–3 Ag research facility called the Wildlife Disease Research Building (WDRB) at NWRC's headquarters campus. The new research building will contain approximately 21,000 sq-ft of user space and will greatly expand APHIS' capabilities to respond to wildlife disease emergencies and resolve important disease issues that involve livestock-wildlife and human-wildlife interactions.

To support both experimental and field investigations, a complete laboratory infrastructure and animal testing capability will be included in the new BSL-3 Ag research facility to provide support for diagnostics methods development, vaccine development, risk assessments, and wildlife disease surveillance and monitoring activities. Diagnostic

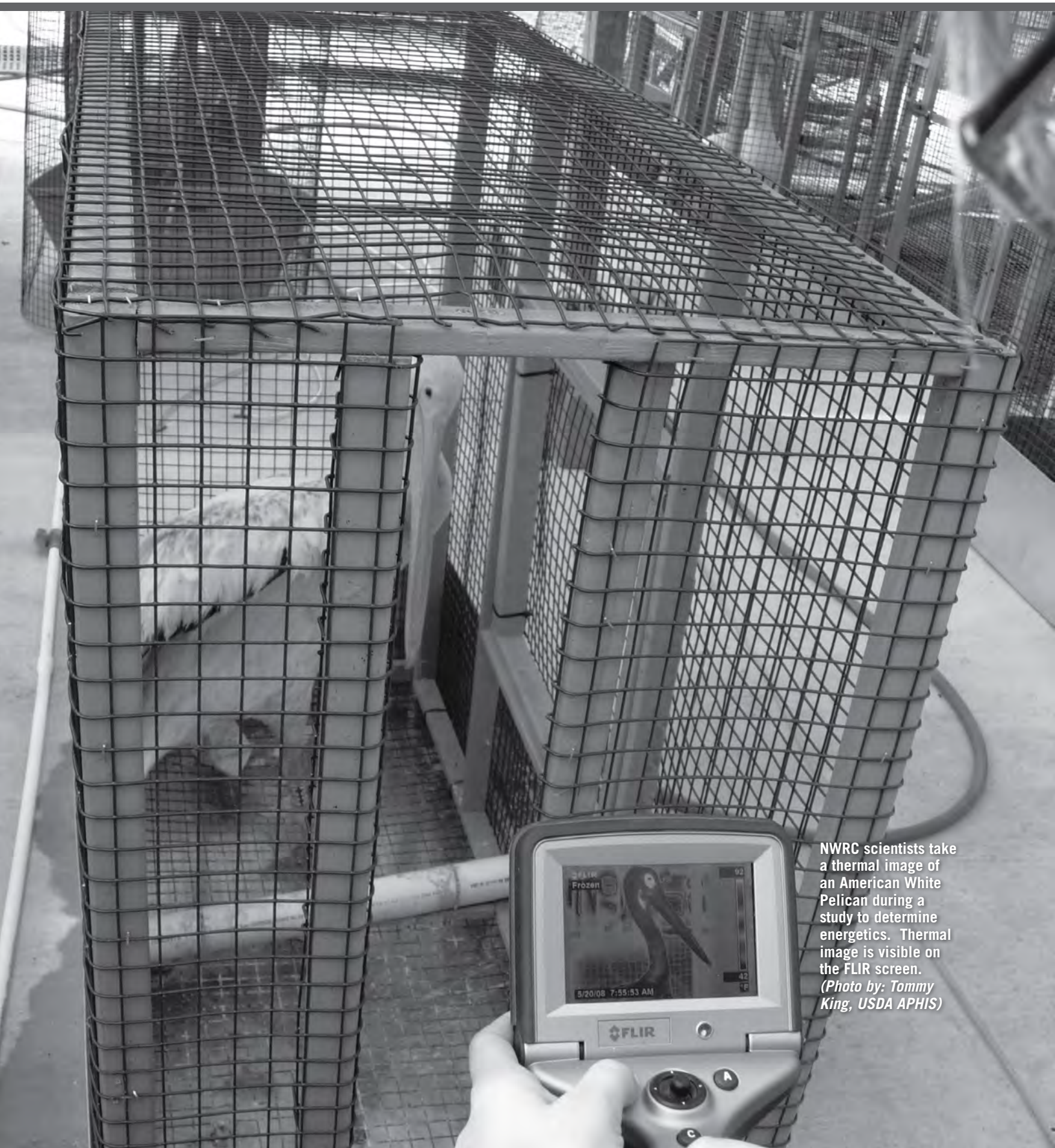
methods development will include rapid diagnostics for diseases in wildlife, such as avian influenza, rabies, tuberculosis, and West Nile virus.

In addition, activities will focus on the development of diagnostic and screening assays for zoonotic and animal pathogens from single samples. The ability to process large numbers of samples for multiple diseases in any surveillance effort will require expanded capabilities for high throughput testing (robotic processing). It will also require controlled biosafety environments for the development and validation of multiplex diagnostic.

The new BSL-3 Ag WDRB will expand NWRC's existing BSL-3 wildlife disease research capabilities. It will also increase opportunities for collaborative research with Colorado State University and other organizations. The "Ag" designation in the BSL-3 description of the WDRB indicates that each animal room is being designed as primary containment for diseased animals; this means the animals can roam freely in the rooms and/or be contained in open cages, neither of which is allowed in standard BSL-3 containment structures. The WDRB user space will include BSL-3 laboratories, up to six BSL-3 Ag animal holding and testing suites, and other ancillary office/support spaces for wildlife disease research purposes.

The WDRB will be owned by a private developer and leased to APHIS through the General Service Administration (GSA). The initial design of the WDRB was completed and discussions were held with potential private developers in FY 2008. In partnership with GSA, APHIS will complete the final design of the WDRB and make a formal solicitation for offers from private developers in FY 2009. The development of construction documents and construction/commissioning of the WDRB building will take approximately 2 to 3 years after an award is made to a private developer. At this time, the estimated completion date for the building is FY 2012.

Developing Methods



NWRC scientists take a thermal image of an American White Pelican during a study to determine energetics. Thermal image is visible on the FLIR screen. ***(Photo by: Tommy King, USDA APHIS)***

NWRC develops nonlethal and lethal tools and methods to reduce and minimize damage from human-wildlife conflicts.

Agriculture and Resource Protection Research Program

The Agriculture and Resource Protection Research Program focuses on reducing bird damage to forest and agricultural crops and aquaculture facilities; reducing bird–aircraft collisions; developing new bird repellents; and reducing livestock predation losses.

TITLE: Defining Economic Impacts and Developing Strategies for Reducing Avian Predation in Aquaculture Systems

GOAL: Develop an understanding of the economic impacts of damage inflicted on aquaculture production systems by cormorants, pelicans, wading birds and waterfowl, and develop tools and techniques for reducing that damage.

NWRC scientists take a thermal image of an American White Pelican during a study to determine energetics.
(Photo by: Tommy King, USDA APHIS)

NWRC employees with captive American White Pelican.
(Photo by: Tommy King, USDA APHIS)

Energetic Requirements of American White Pelicans Analyzed—American White Pelicans routinely forage at commercial aquaculture farms in the southern United States. A better understanding of their daily energetic requirements would help to determine the impact of this species on the aquaculture industry. In May 2008, a scientist from the NWRC field station in Starkville, Mississippi, collaborated with colleagues from Mississippi State University (MSU) and the University of Arkansas to conduct feeding trials with captive American White Pelicans at the NWRC captive bird facility on the MSU campus. Birds were fed a carefully measured diet of channel catfish to determine basic metabolic rate, core body temperature, absorptivity and emissivity for radiation, feather percentage of body mass, caloric content of catfish, insulation efficiency of feathers, and skin resistance to vapor diffusion. NWRC and its university partners will use the data to develop energetic models that estimate the impact of American White Pelicans on the aquaculture industry.

Biomarker Identified as a More Reliable Method for Determining Age in Wildlife Species—NWRC field stations in Florida and Mississippi are developing a new technique to provide a better understanding of bird demographics in the United States. In partnership with West Virginia University, NWRC has identified a biomarker (pentosidine) in the skin of animals, including birds, that is an accurate age predictor. Research findings show this biomarker has the potential to provide a rapid technique for identifying the age of double-crested cormorants, monk parakeets, black vultures, and potentially many other species of birds without the need for more costly and difficult methods. The biomarker aging technique is a potentially valuable resource in the conservation and management of bird species of societal concern.

Cormorant Distribution and Abundance on Catfish Ponds in the Delta Region of Mississippi—The commercial production of channel catfish is the largest aquaculture industry in the United States, with the channel catfish being the fourth most frequently consumed finfish, with fresh and frozen processed product sales in the United States grossing $323 million in 2007. NWRC scientists in Mississippi collaborated with the MS WS Operational Program to evaluate the efficiency of bird survey methods and the factors that affect cormorant use of catfish aquaculture facilities. The research showed that aerial surveys have the potential to accurately estimate abundance. In addition, the presence of cormorants was most likely on food fish ponds relative to fingerling and broodfish ponds. Additionally, the birds' use of catfish pond clusters was related to season of the year, distance of ponds from cormorant roosts, distance from roads, and the number of and distance from cormorant roosts. Farm owners and managers can use this information in timing stocking, harvest, and re-stocking to avoid peak periods of cormorant depredation and reduce depredation impacts.

Double-Crested Cormorant Breeding Colonies in Ontario, Canada—Scientists from the NWRC field station in Starkville, Mississippi, collaborated with scientists from MSU, the Canadian Wildlife Service, and the Ontario Ministry of Natural Resources to determine population characteristics of double-crested cormorants that were breeding across the southern border of Ontario. More reliable information in this area would help managers analyze cormorant population changes, evaluate management efforts, and predict future population trends. This study was designed to compare reproductive parameters on a large geographical scale and provide the data necessary to evaluate approved management actions outlined in DOI Fish and Wildlife Service (FWS) Environmental Impact Statements for managing the impact of double-crested cormorants on aquaculture farms and natural resources. NWRC scientists collected various egg, naked young, fledgling, and adult morphologic data at three geographically distinct breeding areas across southern Ontario during 2006 and 2007.

The results indicate that egg and morphologic variation observed in this study may be the product of environmental plasticity, a regional gradient, and/or two sub-species of cormorants. The number of gulls present on the island, and to a lesser extent cormorant colony size and the number of adult cormorants present, might also impact cormorant fledgling success.

A large-scale collaborative international banding effort was initiated in 2000 in eastern Lake Ontario and in 2002 at Lake of the Woods and North Channel. The study involved NWRC, the WS Operations Programs in New York and Michigan,

Cormorant. *(Photo by: John J. Mosesso, NBII photo)*

MSU, the Canadian Wildlife Service, and the Ontario Ministry of Natural Resources. To date, these efforts have resulted in the banding of more than 11,000 pre-fledged cormorants. Re-observation of these uniquely banded cormorants indicates a survival rate that increases from less than 20 percent for first-year birds to greater than 80 percent for birds 2 years of age and older. Elasticity analysis suggests that a 50-percent reduction in adult survival would reduce the population's finite rate of increase by 25 percent. The data obtained in these studies provide information that can be used to construct population models for developing and evaluating more effective management strategies to reduce the impact of cormorants on commercial and natural resources.

Response of Double-Crested Cormorants to Management Activities on the Breeding Grounds in the Les Cheneaux Islands of Lake Huron, Michigan—Scientists from the NWRC Mississippi Field Station collaborated with WS Michigan and the Michigan Department of Natural Resources to use cormorant management as a means of improving the local yellow perch fishery. Each of several studies addressed a different aspect of the damage attributed to these birds or the management approach for dealing with this damage. Management efforts resulted in a greater than 90-percent reduction in the number of young cormorants produced annually and a greater than 60-percent reduction in cormorant numbers since 2004. Cormorants from the colonies in question fed extensively in the specific areas of perch decline, and perch numbers have improved following the first 3 years of management.

WS Cormorant Harassment Program Evaluated—NWRC scientists collaborated with WS Michigan and USDA's Forest Service (FS) in evaluating a program to reduce predation of sportfish by cormorants during spring migration. The program uses designated agents enlisted to protect fishery resources through an integrated program of non-lethal harassment supplemented by limited lethal take of cormorants. The designated agents receive training, supervision, and supplies from APHIS. In return, the designated agents volunteer their time to conduct harassment operations. This cooperative effort allows APHIS to leverage its WS staff and financing to multiple areas that are experiencing conflict with cormorants. The research documented a large decline in the numbers of cormorant foraging attempts and an increase in walleye populations at Brevoort Lake, Michigan.

For more information about this project, contact Dr. Brian Dorr at Brian.S.Dorr@aphis.usda.gov.

TITLE: New Technologies to Deter Wildlife from Airports and Aircraft

GOAL: To develop and evaluate methods and technologies for reducing the risks of wildlife strikes to civil aviation and to provide scientifically valid methods and techniques to be used on airfields to manage hazardous wildlife.

Translocation of Immature Bald Eagles to Reduce Eagle-Aircraft Collisions—Bald eagles, once endangered in the lower 48 States, have increased exponentially since the pesticide Dichlorodiphenyl Trichloroethane—commonly referred to as DDT—was banned in the United States in 1972. Bald eagle populations recovered sufficiently, and in 2007, the FWS took this species off the Federal List of Endangered and Threatened Wildlife and Plants.

Biologists attaching a satellite transmitter to an immature bald eagle *(Photo by: Alan Schumacher, MN WS)*

Unfortunately, this growth has resulted in increased incidences of collisions between bald eagles and commercial and military aircraft. Bald eagles far exceed the airworthiness standards for airframes, windshields, and engines set by the Federal Aviation Administration (FAA); collisions with this species pose a high level of risk to aircraft and passenger safety.

Biologists from the NWRC Ohio field station collaborated with WS Minnesota to study the effectiveness of relocating bald eagles away from the St. Paul Downtown Airport as a method of reducing the risk of eagle-aircraft collisions. During FY 2008 through 2010, NWRC researchers will determine if or when translocated eagles return to the airfield. The researchers will live-capture a total of five immature bald eagles, fit them with Global Position Satellite-capable transmitters, and release them at various locations away from the airport. Translocated eagles will be tracked using a satellite network to determine their specific movement and activity patterns.

Initial results from this study indicate that translocated eagles remain within 50 miles of their release site and, for at least a couple of months, are not likely to return to the airfield where they are captured. Information from this study will be used to develop effective methods for reducing the risk of collisions between bald eagles and aircraft.

Effigies As Deterrents—Bird control at and around airfields is critical to safe airfield operation. Numerous bird-control products and strategies are available, all of which have limitations due to rapid habituation, ineffectiveness, expense, or other factors. There is a need for new methods to manage birds at airports and other locations. In recent years, realistic effigies of dead turkey vultures have proven effective as a species-specific means to disperse

roosting vultures. To determine if this concept can be expanded to deter other birds that are a problem at airfields, NWRC researchers conducted trials using prepared ring-billed and herring gulls as effigies at landfills, a nesting colony, and a containment disposal facility next to an airport. Results at landfills varied according to their distance to the active dumping area (active face) and the time of year. In winter, gulls loafing away from the active face would stay clear of effigies for up to 4 weeks. When set on or adjacent to the active face, gulls would initially disperse but then return within hours to weeks. Effigies were not effective in nesting colonies. Gull reaction to effigies at a containment disposal facility showed initial good response, especially when reinforced with pyrotechnics and lethal control; however, habituation occurred after 2 months of exposure. The researchers concluded that although effigies alone will not keep gulls away from extensive areas, when used as part of an integrated bird control program, they can reduce gull presence in specified areas.

Earthworm Hazards on Airport Runways—Scientists in Ohio are investigating methods for keeping earthworms off of runways at airports. Although earthworms generally are considered beneficial, they can be a hazard at airports, especially when found in large numbers on runways or taxiways after heavy rainfall. Additionally, earthworms attract birds, especially gulls, thereby increasing the risk of bird strikes to aircraft that are landing or taking off. A dramatic example of this occurred during a 35-minute period on September 3, 2004, at Calgary International Airport (YYC). A Canadian commercial B737 and an A319 jet aborted takeoffs after multiple strikes with gulls attracted to the runways to feed on earthworms. The B737 had strikes and damage to both engines and the A319 had damage (apparently uncontained failure) to one engine.

NWRC biologists in Ohio are testing naturally occurring compounds as earthworm repellants on airport runways. (*Photo by: iStock)*

Currently, no pesticides are registered or legally available for controlling earthworms, and the high costs associated with development and registration probably preclude this option. Therefore, the NWRC researchers are investigating the use of inert, abrasive materials, naturally occurring compounds, and fertilizers to reduce earthworm incursions onto runways. Initial lab results from research conducted at the NWRC field station in Sandusky, Ohio, identified several naturally occurring compounds that show promise as worm repellents, but additional lab and field tests are needed before these substances can be evaluated on airfields. As with most wildlife damage management scenarios, the researchers anticipate that an integrated approach will be necessary to reduce the number of worms crawling onto runways. Future research plans call for the evaluation of a repellent in combination with a soil additive that creates a more acidic and perhaps abrasive soil in areas of concern at airports.

For more information about this project, contact Dr. Travis DeVault at travis.l.devault@aphis.usda.gov.

TITLE: Improved Technologies and Non-Lethal Techniques For Managing Predation

GOAL: To identify, develop, and evaluate improved technologies and tools, especially non-lethal methods for managing predation

Trap Devices Tested For Capturing Canids—Due to a growing international concern for animal welfare and the need to capture and handle specific species for conservation, management, or recreational purposes, there is an increasing need for scientific evaluation of capture methods. Scientists at the NWRC field station in Millville, Utah, evaluated the efficiency and selectivity of cable restraint devices and cage-traps for the capture of red foxes and the incidence of injury to captured animals at 4 sites in Castilla y León (Spain) during spring 2006. All traps performed similarly at all sites, with no apparent site and trap interactions. Fox capture rates and mechanical efficiencies of the Belisle (Edouard Belisle, Saint Veronique, Québec, Canada) and Collarum (Wildlife Control Supplies, East Granby Connecticut, United States) were similar, but both had higher capture rates than the cage-trap. Similar to previous studies, the Collarum was 100-percent selective for canids and had a selectivity of over 94 percent overall, which was higher than that for the Belisle (63 percent); both Collarum and Belisle were much more selective than the cage-trap (21 percent). Fox injuries were statistically indistinguishable using injury scores, but the Collarum and the Belisle surpassed international standards for humane trapping; the number of animals captured in cage-traps was insufficient to allow for evaluation. While both the Collarum and the Belisle may be useful for capturing foxes in Spain, training and experience with each may be necessary to ensure the highest efficiency while still preventing injuries, especially to non-target species.

A cage trap designed to capture foxes that were tested in Spain. *(Photo by: John Shivik, NWRC)*

Using Aversive Conditioning to Repel Bears—NWRC scientists are investigating whether taste-aversion conditioning is effective at reducing black bear visits to food sources. Taste-aversion conditioning occurs when the taste and/or smell of a flavor is associated with severe gastro-intestinal malaise, such that an animal subsequently rejects or avoids that food. Conditioning occurs most effectively when a novel flavor is used. In recent years, conflicts with bears and human-bear encounters have amplified, jeopardizing both human and bear safety, especially where human food sources are available (e.g., in campgrounds). This increase in nuisance activity has prompted a need for wildlife managers to explore and implement successful predator conflict management techniques. Many varied management techniques, both lethal and non-lethal, have been used to reduce human-wildlife conflicts. While methods using both approaches have been successful at reducing

A surveillance camera image of a black bear accessing a trash can in a simulated campground in Utah. *(Photo by: NWRC/USDA)*

some conflicts, there has been a growing interest from wildlife managers and the public in using less-invasive, non-lethal means of wildlife and predator management.

However, since the nature of wildlife conflicts is diverse, and many non-lethal management tools are limited in their capacity to reduce conflict, it is important to develop a variety of techniques to mitigate these problems. Taste-aversion conditioning is one potential alternative. NWRC scientists are conducting research to determine the effectiveness of thiabendazole (TBZ) for establishing a taste-aversion to a flavor and test the effectiveness of this method at reducing or preventing bear visits to food sources. TBZ is particularly promising because, unlike other chemical aversive agents used in the past, this compound is believed to be relatively tasteless and odorless, allowing for animals to form an aversion to the flavor of the food consumed and not to the chemical itself.

At the end of 2007, NWRC completed the first round of experiments with captive and free-ranging black bears to examine the effectiveness of conditioned taste aversion (CTA) for reducing food consumption and visitation at campgrounds and other food sources. NWRC researchers tested captive black bears by offering them food (donuts) treated with 10 g of TBZ and a novel flavor (peppermint) on three different occasions; bears fully consumed treated bait each time, and CTA was never established. Subsequently, the researchers conducted a field experiment in the La Sal Mountains, Utah. They established and constructed 26 simulated campground sites using plastic trash bins containing 300 g of baked goods (cakes, donuts). After 4 weeks, they treated 50 percent of the sites with 10 g of TBZ and a novel flavor (camphor). While bear visits to the simulated campgrounds were not reduced using TBZ, food consumption appeared to be reduced at some sites. NWRC is continuing additional studies of free-ranging bears in FY 2009 that will help determine why previous tests of flavor avoidance conditioning with TBZ had limited success.

For more information about this project, contact Dr. John Shivik at john.shivik@aphis.usda.gov.

TITLE: Documenting Impacts, Developing Control Strategies, and Applying Knowledge of Predator Behavior and Demographics to Protect Livestock and Natural Resources

GOAL: Improve current knowledge of predator ecology, physiology, and behavior relative to depredations on species of human concern, assess predator responses to management practices, and develop control approaches that effectively target alpha coyotes.

Do Wolves Limit the Distribution and Abundance of Coyotes?—Scientists at the NWRC field station in Logan, Utah, are investigating whether competition

Wolves feeding on elk carcass. *(Photo by: Eric Gese, NWRC)*

from wolves limits the distribution and abundance of coyotes, and whether the elimination of wolves from certain areas has resulted in the coyote range expansion throughout much of North America. The scientists analyzed spatial, seasonal, and temporal variation in wolf distribution and abundance to test the hypothesis that competition with wolves limits the distribution and abundance of coyotes. From 2001 to 2004, the researchers gathered data on cause-specific mortality and survival rates of coyotes captured at wolf-free and wolf-abundant sites in Grand Teton National Park (GTNP) in Wyoming to determine whether mortality due to wolves is sufficient to reduce coyote densities. They also examined whether spatial segregation limits the local distribution of coyotes by evaluating home-range overlap between resident coyotes and wolves, and by contrasting dispersal rates of transient coyotes captured in wolf-free and wolf-abundant areas. Finally, they analyzed data on population densities of both species at three study areas across the Greater Yellowstone Ecosystem (GYE) to determine whether coyotes were less abundant where wolves were common.

Although coyotes were the numerically dominant predator across the GYE, densities varied spatially and temporally in accordance with wolf abundance. Mean coyote densities were 33 percent lower at wolf-abundant sites in GTNP, and densities declined 39 percent in Yellowstone National Park following wolf reintroduction. A strong negative relationship between coyote and wolf densities, both within and across study sites, supports the hypothesis that competition with wolves limits coyote populations. Overall mortality of coyotes resulting from wolf predation was low, but wolves were responsible for 56 percent of transient coyote deaths. In addition, dispersal rates of transient coyotes captured at wolf-abundant sites were 117 percent higher than for transients captured in wolf-free areas. The scientists concluded that coyote abundance is limited by competition with wolves, and that differential effects on survival and dispersal rates of transient coyotes are important mechanisms by which wolves reduce coyote densities.

Coyote Scavenging Ecology and Recolonizing Wolves in Montana's Madison Range—Inference from studies of competition between species can be constrained where competitors have occupied the same area for long periods and little change in behavior is evident. Fortunately, wolf recolonization of the GYE provides a rare opportunity to identify new behaviors facilitating coexistence between species of canids. Accordingly, NWRC scientists in Logan, Utah, investigated behavioral interactions between putatively naïve coyotes and recolonizing wolves at ungulate carcasses in Montana's Madison range. The scientists employed a quasi-experimental study design consisting of a 3-level carcass treatment (actual wolf presence, simulated wolf presence, wolf absence) to assess factors influencing coyote risk assessment, carrion consumption, and aggressive encounters with wolves.

Socially dominant coyotes (alphas and betas) responded to actual and simulated wolf presence by increasing the proportion of time spent vigilant while scavenging. Vigilance behavior was more pronounced when scavenging closer to protective cover, where visual obstacles inhibited the ability of coyotes to scan for, and possibly escape from, returning wolves. Despite greater time spent vigilant, alpha coyotes consumed the greatest amount of carrion biomass. This was accomplished by feeding on carcasses in earlier stages of consumption when organs and large muscle tissues were still present. This suggests that alpha coyotes might trade-off greater risk for higher quality food items. Coyotes aggressively confronted wolves. Numeric superiority of coyotes and the stage of carcass consumption were influential in determining whether coyotes were able to displace wolves from carcasses. Coyotes relied on a gradient of risk-sensitive behaviors, ranging from elevated vigilance to aggressive confrontation, to manage risk associated with wolf presence. Identification of these behaviors and their sensitivity to numeric and social factors are important steps in elucidating mechanisms that allow social canids to occupy the same area.

For more information about this project, contact Dr. Eric Gese at eric.m.gese@aphis.usda.gov.

TITLE: Defining Impacts and Developing Strategies to Reduce Mammalian Damage in Forested and Riparian Ecosystems

GOAL: Develop an understanding of the economic and ecological impacts of damage inflicted on forested and riparian systems by herbivorous and omnivorous mammals, and develop tools and techniques for reducing that damage.

Ten species of plants present during seedling planting in late winter were offered to captive mountain beaver to determine preference. *(Photo by: Wendy M. Arjo, NWRC)*

Forage Manipulation to Reduce Seedling Damage by Mountain Beaver—Mountain beavers have long been recognized as a problem to reforestation efforts in the Pacific Northwest. Although studies have demonstrated that forest management practices (e.g., harvesting and site preparation) affect home ranges, population densities, and reproductive effort, little information is available on forage preference. Scientists at the NWRC Olympia field station have documented that site preparation does not appear to directly relate to seedling damage, and that the availability of water, which can be in the form of succulent vegetation, may be playing a role in seedling damage. Understanding the effects of vegetation on population demographics, forage preference, and subsequent seedling damage may allow for initiating a non-lethal management method using alternative forage. NWRC conducted a series of pen experiments to determine the importance of water and "preferred" plant species available at planting time. Scientists were able to record behaviors for each of the two-choice test as well as the cafeteria trial to determine the fate of each plant species offered. Mountain beavers were found in the cafeteria trial to prefer plants containing higher moisture content. In addition, the beaver preferred

NWRC scientists and technicians measure Douglas-fir seedlings every 6 months to determine growth and herbivore damage during the first 5 years of stand establishment. *(Photo by: Kelly Perry, NWRC)*

wet sword fern (not oven dried) and wet salal more than dried plants of each species. Mountain beaver consumed sword fern in greater quantities than the salal. Choice and preference by mountain beaver may also be related to tannin content. NWRC has planned one additional experiment to test mountain beaver preference with known monoterpene levels in western red cedar.

Defining Ungulate Browse Timing and Intensity—Oregon and Washington are the United States' leading producers of forest products. In western Oregon and Washington, the dominant commercial tree species is Douglas-fir which is generally planted at a density of 400 to 450 trees per acre and harvested on a 40- to 45-year rotation. In general, sites are chemically prepared for planting by aerial application, and logging slash is piled and burned. Between planting and harvest, silvicultural prescriptions may include pre-commercial thinning, fertilization, commercial thinning, and herbicide applications. Although timber companies invest in measures to prevent ungulate browse, there are no published results of cost-benefits associated with these actions. Furthermore, forest resource managers acknowledge that the measures are generally ineffective and that millions of dollars are lost annually to ungulate browse. To better understand the timing and severity of deer and elk browse on reforestation efforts in western Oregon and Washington, NWRC field station scientists in Washington initiated two new 5-year studies in the spring of 2007. After 1 year of monitoring seedlings in areas exposed to browse versus those excluded from browse, both bud cap-protected seedlings and plugs inside fences were taller and had a greater basal diameter than those seedlings outside the fences. Ungulate presence varied between units, but appeared to be the greatest during October and late winter. In one unit comparison, greater than 30 percent of the seedlings received heavy terminal damage that will likely affect future growth. Scientists will continue to monitor the units for 4 more years in order to gain knowledge on the timing, persistence, and level of damage of ungulates (deer and elk) on Douglas-fir seedlings from 0 to 5 years of age. Results will help land managers make better decisions for forest planning in areas providing habitat to deer and elk.

Using Genetics to Determine Diversity, Mating Strategies, and Phylogeny in the Mountain Beaver—Delineating geographic and anthropogenic barriers that affect gene flow across the landscape within a species is important for the management of sensitive and pest species. The mountain beaver is unique in that it fits into both categories: the species is managed as a sensitive species in the extreme southern and northern part of its ranges and as a pest species in the central portion of the range. Current understanding of the single *Aplodontia*

Using genetic analyses to determine gene flow and dispersal in managed mountain beaver populations. *(Photo by: Melissa Neubaum, NWRC)*

species, based on morphological characteristics, identifies seven subspecies that range from central California to British Columbia. Climatic changes, physical geographic changes to the coast line, and fragmentation of boreal forest communities followed by more recent urban development likely have contributed to the isolation of three subspecies in California. In Canada, mountain beavers are designated as species of concern with forest harvesting thought to be the leading cause of population declines. NWRC scientists hypothesize that forest management practices in western Washington may have promoted the ability of *A. rufa* to maintain genetic diversity across a broad geographic landscape. Using telemetry, biologists documented mountain beavers dispersing greater than 300m with rapid reinvasion into newly harvested areas. Using mitochondrial DNA (mtDNA) from 7 distinct mountain beaver demes, they identified 13 haplotypes shared among demes, suggesting gene flow between the demes. Despite anthropogenic changes across the western Washington landscape, historic genetic diversity inferred from mtDNA appears to be maintained in the *A. rufa* subspecies. Additionally, mtDNA supports some of the subspecies designations.

For further information about this project, contact Dr. Jimmy Taylor at jimmy.d.taylor@aphis.usda.gov.

TITLE: Evaluation of Wildlife Food Plots, Repellents, and DRC–1339 "Take Models" for the Management of Blackbirds and Starlings in Sunflower Fields, Feedlots, and Dairies

GOAL: To develop new and scientifically valid methods to reduce blackbird and starling damage to ripening sunflower crops, feedlots, and dairies

Bird Repellents—Scientists at the NWRC field station in Bismarck, North Dakota, evaluated registered pesticides as blackbird repellents for protecting seeded rice and ripening sunflower. The scientists evaluated three compounds used as seed treatments (Vitavax®, Thiram®, Allegiance®), one registered insecticide (Cobalt®), and one registered bird repellent (Flockbuster®) in a series of no-choice feeding trials and preference tests. They also tested all candidate repellents at various concentrations to develop a dose-response relationship. Scientists observed that as Vitavax concentrations were increased, the amount of food eaten by red-winged blackbirds decreased. Maximum repellency, however, was only 49 percent at 200 percent Vitavax label rate, which is considered too low for good repellency in field applications. Similarly, NWRC tested FlockBuster repellent and Cobalt as blackbird

repellents for sunflower. Relative to the 3-day pretreatment, scientists observed greater consumption of treated sunflower among all groups during the no-choice test of FlockBuster; that is, the birds were attracted to sunflower treated with FlockBuster. In comparison, captive red-winged blackbirds preferred untreated rice during the Cobalt preference test. Scientists observed that as the concentration of Cobalt increased, the amount of food eaten by red-winged blackbirds decreased. NWRC will not pursue Cobalt as a bird repellent but will test the formulation components individually for repellency. A reliable foliar bird repellent would be highly valuable to both the rice and sunflower industries.

European Starlings in Dairies—European starlings are potential vectors in the transmission of *E. coli* O157:H7 among livestock herds. As part of a multidisciplinary study that included microbiological and genetic research on the *E. coli* O157:H7 pathogen, NWRC collaborated with The Ohio State University to radio-tag 49 starlings at 5 dairies in Wayne County, Ohio. From September 19 through October 31, 2007, scientists tracked the radioed birds using a combination of mobile and fixed-site receiving systems. Of the 49 radio-tagged birds, 31 provided enough data for analysis. The results showed strong fidelity to the capture site, with 67 percent of daily visits occurring at the individuals' capture sites. Visits to dairies other than the individual's capture-site represented 33 percent of the daily visits, and most of these occurred at 2 adjacent dairies located 1.2 km apart. The median number of non capture-site dairies the 31 birds visited over the study period was 2. Some birds roosted at dairies; however, a wetland about 16 km northeast of the study area was the main roost. If microbiological and genetic research on *E. coli* O157:H7 reinforce the findings of confined areas of starling activity, it is likely that NWRC will recommend a management program to prevent disease transmission.

Mist nets were used to capture starlings that were radio-tagged. *(Photo by: Jeffrey LeJeune, NWRC)*

Two NWRC scientists (Scott Werner and Shelagh Tupper) holding captive red-winged blackbirds. *(Photo by: USDA)*

For further information about this project, contact Dr. George Linz at george.m.linz@aphis.usda.gov.

Wildlife Disease Research Program

The Wildlife Disease Research Program explores ways to reduce the spread and transmission of diseases from wildlife to humans and domestic animals, monitors wildlife for pathogens, provides risk assessments for agriculture and human health and safety, and assists WS Operations in surveillance and monitoring efforts.

TITLE: Controlling Wildlife Vectors of Bovine Tuberculosis

GOAL: To study the ecology of wildlife diseases, assess the risk of disease transmission among wildlife, domestic animals, and humans and develop methods that reduce or eliminate such transmission

Bovine tuberculosis (bTB) is a contagious disease affecting livestock, wildlife, and humans. The disease is typically spread through aerosolized bacilli or contact (direct or indirect) between individuals.

Use of Coyotes to Detect Presence of bTB and Evaluate Shedding of bTB—In Michigan's northeastern Lower Peninsula (NELP), bTB is endemic in free-ranging white-tailed deer, indicating that deer might be spreading the disease to domestic livestock. Typically, bTB is monitored through regular testing of cattle and inspection of hunter-harvested deer. However, other species besides cattle and deer can act as reservoirs for bTB. *Mycobacterium bovis*, the causative agent of bTB, has been detected in bobcats, coyotes, opossums, raccoons, black bears, foxes, and other species. Previous research has estimated that the bTB prevalence in coyotes is approximately 30 percent. In addition, research suggests that coyotes may act as sentinel species for bTB. Coyotes typically become exposed to *M. bovis* by ingesting infected deer carcasses and offal, which indicates that coyotes might actively shed the bacterium in their feces or oral and nasal secretions, potentially contributing to the spread of the disease.

NWRC scientists captured and examined coyotes in eight infected counties in the NELP to evaluate whether the animals shed *M. bovis* and to determine whether coyotes in uninfected counties carry bTB, which could indicate spread of the disease and a risk to currently uninfected livestock. Of the 142 coyotes cultured to date, 13 were positive for bTB, with an additional 3 classified as "suspect cases," because they were bTB positive under histopathology but had negative cultures. In a concurrent study, the NWRC scientists found that a low dose of *M. bovis* did not result in bTB in coyotes, which suggests that free-ranging coyotes might be ingesting large quantities of infected tissue, resulting in a positive diagnosis.

Evaluation of Oral Baits for Vaccine Delivery Using Captive White-Tailed Deer—The implementation of an oral vaccination program that would effectively

Free-ranging coyote. *(Photo by: T. Riley)*

Apple and molasses bait piles in the snow in Michigan. *(Photo by: D. Kilpatrick, USDA NWRC)*

Remote camera photo of deer investigating the molassess bait during the preference testing. *(Photo by: USDA NWRC)*

reduce disease and shedding of the organism, *M. bovis*, by deer and possibly other affected species would significantly aid efforts in eradicating bTB from Michigan and potentially from Minnesota as well.

A collaborative study NWRC and APHIS-Veterinary Services (VS) scientists conducted indicates that the oral vaccine, Bacilli Calmette-Guerin (BCG), can be effective in protecting white-tailed deer from *M. bovis* infection. NWRC scientists have expanded this research to evaluate if deer will consume a newer version of lipid matrix that may increase both dispersal options (hand and aerial dispersal) and weather resistance. Preliminary results look promising.

For more information on this project, contact Dr. Michael Dunbar at michael.r.dunbar@aphis.usda.gov.

TITLE: Evaluation and Management of Chronic Wasting Disease (CWD) Transmission

GOAL: To assess the potential for CWD transmission at the interface between wild and domestic cervids and develop methods to reduce transmission and spread

The spread of CWD in wild and captive cervids is of great concern nationwide. To effectively eradicate CWD, scientists and animal health officials need more information about the transmission of this disease at the interface between wild and domestic cervids. CWD infects elk, white-tailed deer, mule deer, and moose, but is not known to naturally infect other species of wildlife (including predators and scavengers), livestock, or humans. There is no treatment for CWD, and it is typically fatal in cervids. Realized and perceived threats of CWD have immense implications for Federal and State wildlife management agencies, domestic cervid farmers, and hunters, as well as businesses and economies that rely on deer and elk. In addition, animal health officials need additional and enhanced tools and techniques to reduce the transmission, prevalence, and persistence of CWD in wild and captive cervids.

Validation of Proximity Loggers to Study White-Tailed Deer Contact at Fine-Scales—Studies of deer behavior use techniques such as radio telemetry, which does not have the spatial resolution needed for closely identifying contact behaviors. NWRC scientists are determining if data-logging collars (Sitrack Tracking Solutions, Ltd., New Zealand) are reliable for collecting data at fine-scale resolution. During 2007 and 2008, NWRC equipped

22 white-tailed deer (11 doe-fawn pairs) with the collars and conducted six 3-day trials in a 2-acre pen. The scientists cross-referenced data from the data-loggers with visual observation data collected 1 hour before and after sunrise and sunset. NWRC is now analyzing those data to determine whether disease transmission through direct contact between inter- and intra-related white-tailed deer increases when deer become concentrated at supplemental food sources provided by humans. This question is critical for the regulation of deer baiting and supplemental feeding for hunting and wildlife viewing. It is of special relevance in the Great Lakes and midwestern States where recent outbreaks of transmissible diseases, such as CWD and bTB, have occurred in captive and wild deer populations.

Ecology of Male White-Tailed Deer in the Missouri River Valley—Estimates of home range, movements, and survival are crucial to understanding white-tailed deer population dynamics. Knowledge of these parameters can help wildlife managers establish harvest goals and design management strategies for monitoring and controlling diseases. From 2004 to 2008, NWRC scientists evaluated the home ranges and movements of 85 radio-marked male white-tailed deer at the DeSoto National Wildlife Refuge (DNWR) in the Missouri River Valley (MRV) of eastern Nebraska and western Iowa. The mean annual home range size was 489 hectare (ha). Seasonal home ranges were smallest during summer (266 ha) and largest during the fall (465 ha). Seventy-one percent of yearling males dispersed a mean distance of 14 km, with 1 ear-tagged yearling moving 121 km. Longer distance movements of adult males were less pronounced. Two adult bucks migrated 3.0 and 4.5 km, and temporary excursions ranged from 1.3 to 6.0 km. While deer dispersing from DNWR help maintain populations in outlying areas, they also create a potential risk for rapid transmission of disease throughout the MRV should they become infected.

Resource Selection and Dispersal Direction of Sympatric Deer in Western Nebraska—Knowledge on interspecific relationships and directional

Test fence to exclude free-ranging deer from cattle pastures. *(Photo by: Kurt VerCauteren, NWRC)*

NWRC biologist examining white-tailed deer in CWD study. *(Photo by: Kurt VerCauteren)*

movements of sympatric species such as white-tailed deer and mule deer is important, especially in areas where CWD is endemic. The potential for contact, and thus transmission of disease, between species is related to their resource selection and spatial overlap. In 2004, Morrill County, Nebraska, was positioned on the eastern edge of the core endemic area for CWD. NWRC scientists initiated a 3-year study in the county to evaluate resource selection, home range size and location, movement patterns, and behaviors of mule deer and white-tailed deer relative to CWD transmission. The scientists radio-collared 48 white-tailed and 43 mule deer and collected data from greater than 16,600 locations from April 2004 through June 2007. Quantifying the likelihood of interactions between white-tailed deer and mule deer (direct or indirect contact) is critical for determining interspecific transmission and spread of CWD.

Biologists used resource selection functions to determine that 34 percent (1,500 km^2) of Morrill County had a high annual probability of use by both sexes of white-tailed deer and mule deer, indicating a definite overlap in the relative use of space.

The data also showed differences in dispersal movements for white-tailed deer and mule deer. White-tailed deer dispersed in directions parallel to river valleys, while mule deer often dispersed perpendicular to river valleys. The differences in dispersal direction indicate that white-tailed deer infected with CWD are likely to remain within the river valley, whereas mule deer may spread CWD among river valleys.

Evaluation of a Novel Electric Fence For Minimizing Contact of Deer With Cattle—Recent findings of bTB in cattle and free-ranging white-tailed deer in northwest Minnesota prompted NWRC to investigate alternative means for minimizing deer use of cattle pastures and stored cattle feed. An easy-to-implement, temporary fence that can be effective when deer are food-stressed could serve to keep potentially infected deer from contacting cattle and cattle feed. Researchers evaluated a candidate fence on 20 field sites just outside the bTB-core

CWD Barrier Fence. *(Photo by: Kurt VerCauteren)*

area in Minnesota. The novel fence consisted of four strands of a bi-polar polytape that combined both charged and ground wires in one tape. The polytape was coated with a peanut butter and molasses mixture to entice deer to approach and contact the fence, therefore receiving a substantial electrical shock. The goal was to condition deer to avoid and not cross the fence. Although NWRC has not yet fully analyzed the data, initial results show that the fence did not completely exclude deer at sites with the highest deer presence.

For more information on this project, contact Dr. Kurt VerCauteren at kurt.c.vercauteren@aphis.usda.gov.

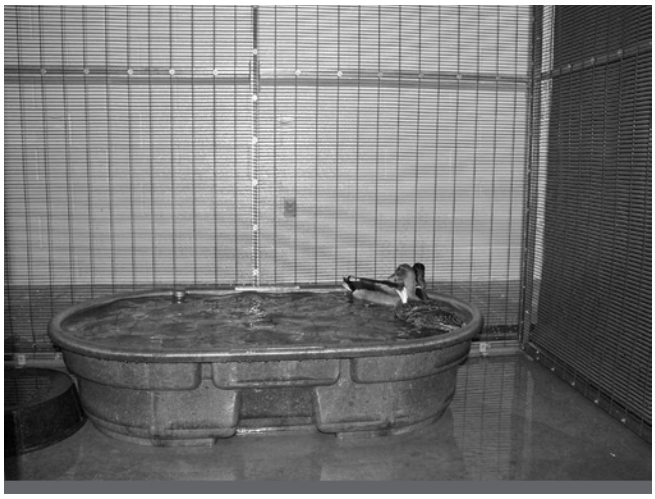
TITLE: Ecology of Emerging Viral & Bacterial Diseases in Wildlife (EEVB)

GOAL: To understand the ecological role of wildlife in the transmission and movements of pathogens causing diseases of importance to agriculture, human health, and wildlife management issues, with an emphasis on avian influenza viruses, bacterial pathogens and other emerging pathogens; develop probability-based and/or spatially-explicit (GIS) risk assessments for wildlife pathogens, improving laboratory diagnostic methods and capabilities for detection of pathogens and exposure to pathogens; integrate novel approaches and concepts from other disciplines into research on wildlife disease ecology

Lake Nakuru, a major waterfowl area in Kenya. *(Photo by: NASA Earth Observatory image)*

Northern Pintail, which regularly migrates between Europe and Kenya. *(Photo by: David Menke, FWS)*

Over the last decade, there has been considerable concern in the United States about emerging and re-emerging wildlife diseases that affect agricultural production, food safety, and human health. For example, the recent global spread of highly pathogenic avian influenza (HPAI) subtype H5N1 has caused considerable concern about potential future pandemics caused by avian influenza (AI) viruses that could affect agricultural interests (e.g., poultry production) and human health. In addition, contamination rates of beef by pathogenic bacteria (e.g., *Escherichia coli* strain O157:H7) have increased in recent years, resulting in food safety issues and costly product recalls.



Experimental setup at NWRC to examine transmission of low-pathogenic avian influenza virus from waterfowl through water. *(Photo by: Kevin Bentler)*

Experimental setup to examine the utility of Nobuto® strips for detecting West Nile virus in red-winged blackbirds in the BSL-3 laboratory at NWRC. *(Photo by: Kevin Bentler)*

This NWRC project attempts to deal with these concerns by examining the roles of wildlife in maintaining and transmitting pathogens, such as AI viruses and pathogenic bacteria, to agricultural operations and humans. This new project began in 2008 and continues research activities from the previous Surveillance, Monitoring, and Research project.

Experimental Infections of Waterfowl with Avian Influenza—Water represents a potential route of transmission for AI viruses from infected wild waterfowl to uninfected waterfowl, peri-domestic wildlife, and feral swine. However, viral loads in feces shed by waterfowl and subsequent concentrations of AI viruses in water bodies have not been evaluated specifically. A more accurate understanding of this mechanism is critical for determining the risks associated with AI. NWRC scientists in Fort Collins, Colorado, are evaluating the density of infected waterfowl necessary for the detection of AI viruses in water and whether contaminated water can facilitate the transmission of AI viruses to uninfected waterfowl. In preliminary studies, mallards were inoculated with the three major influenza subtypes found in wild birds. All mallards showed sero-conversion and high shedding rates of virus as sampled with oral-pharyngeal swabs, cloacal swabs, and fecal swabs. In addition, high levels of virus were detected in the water used by these ducks. Final experiments are currently ongoing to examine transmission rates of AI virus through water.

Use of Nobuto Strips® to Detect West Nile Virus Exposure in Wildlife—To better understand the exposure of wild birds to West Nile virus (WNV), the NWRC is initiating numerous sero-surveys for WNV antibodies across the United States. However, processing whole blood in the field can be challenging, time consuming, and expensive. NWRC scientists are investigating an alternative method for whole blood collection that uses commercially available blood filter strips, or Nobuto strips. This method has been used to analyze whole blood samples for several diseases from various hosts. NWRC investigators are evaluating the use of Nobuto strips for the detection of WNV-specific antibodies using current serological screening tests and the standardization of epitope-blocking and indirect enzyme-linked immunosorbent assay (ELISA) for use with Nobuto strips.

NWRC selected red-winged blackbirds as a model avian system because they are an abundant species (~150 million in North America) whose migratory movements are consistent with the 2002 North American expansion of WNV, they are host competent for WNV, they utilize wetlands during migration and breeding where mosquito vector populations are abundant, and they circulate infectious levels of WNV. In addition, this species has been identified as a risk factor for equine cases of WNV infection. Horses distributed along riparian and bottom lands that contain blackbird roosts or are waterfowl staging areas may have a higher likelihood of becoming infected with WNV. The BSL-3 experimental infection portion of this study is complete, and NWRC is analyzing the serum and Nobuto strip samples.

Studies on the Ecology of AI Virus in Feral Swine With Implications For Agriculture—Swine are an important reservoir for influenza viruses of both human and avian origin and are considered a "mixing vessel" for these influenza viruses, allowing for the potential genetic reassortment of viruses. Feral swine are an invasive species with populations established in over 39 States. Feral swine have been reported as far north as Wisconsin and Michigan, and their range continues to expand. Feral swine interact with livestock primarily through shared water and food sources. As mixing vessels, these swine could potentially spread HPAI viruses to domestic animals via these shared sites.

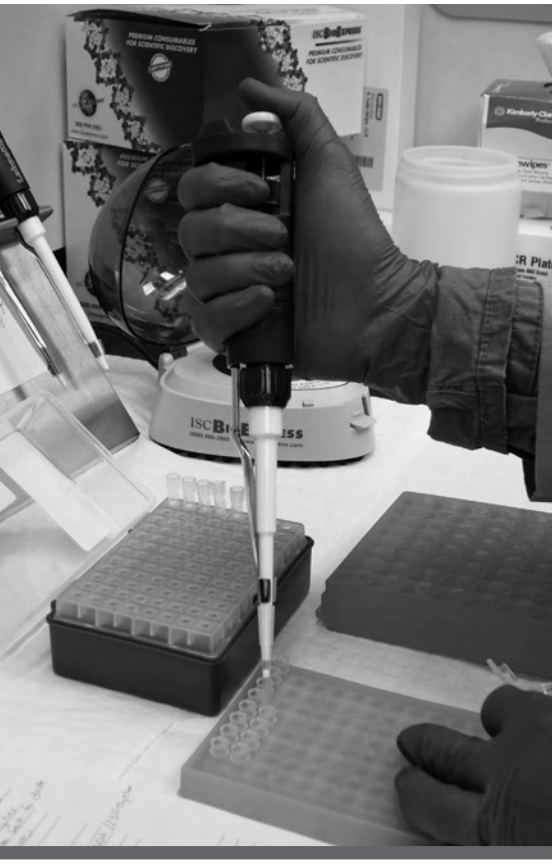
NWRC scientists have initiated long-term programmatic studies to examine the direct and indirect interactions of feral swine with water birds infected with HPAI viruses and the subsequent spreading of these viruses to domestic swine operations. There are a number of potential pathways through which HPAI could be transmitted among waterfowl, including contaminated water bodies used by waterfowl, wildlife, and feral swine, and ultimately, domestic swine as well. In developing these studies, NWRC scientists developed and used a conceptual model of potential transmission pathways to define field and laboratory studies and the empirical data needed to convert the conceptual model into a probabilistic risk assessment model.

Invasive feral swine have been introduced into numerous countries where they cause significant damage to natural and agricultural resources. *(Photo by: David Long, USDA)*

Backyard poultry flock in Colorado. *(Photo by: Susan Shriner)*

AI Outbreak Response Based on Network Models—One of the most common responses to AI outbreaks is to impose a control or surveillance area around the center of an outbreak. For example, in response to a recent outbreak of low pathogenic avian influenza (LPAI) in Arkansas, a 10-mile radius surveillance zone was put into place around the outbreak location. NWRC scientists are evaluating the potential gains in outbreak control efficiency when control zones are based on the actual locations of neighboring poultry operations, rather than simply placing a circular control area around the outbreak center. To test the utility of basing control areas on farm locations, the scientists developed a network of poultry operations in Colorado based on actual farm locations. NWRC developed a computer simulation model that randomly initiates an LPAI outbreak at a farm in the network and then predicts the probability of the virus spreading to another facility when equal-area circular or network-based control areas are imposed. Preliminary results indicate that network-based control areas reduce the probability of viral movement. Currently, NWRC is refining the model to assess potential efficiencies associated with network-based outbreak control strategies.

For more information about this project, contact Dr. Alan Franklin at alan.b.franklin@aphis.usda.gov.



Preparing the samples for amplifying and detecting the microsatellite markers. *(Photo by: USDA)*

TITLE: Investigating the Ecology, Control, and Prevention of Terrestrial Rabies in Free-Ranging Wildlife

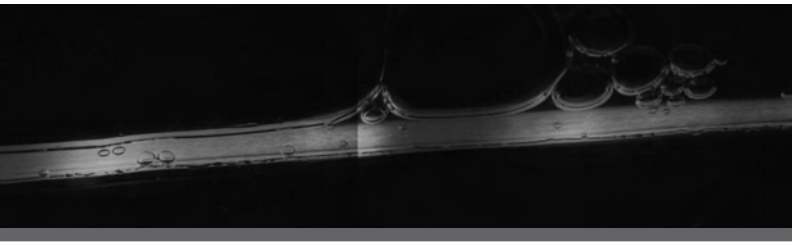
GOAL: To study the ecology of wildlife and evaluate risk factors that may be involved with the transmission of rabies among wildlife and rabies virus trafficking across landscapes and develop methods and strategies that reduce or eliminate such transmission

Rabies is an acute, fatal viral disease most often transmitted through the bite of a rabid mammal. It can infect people as well as animals. The societal impacts from this and other wildlife diseases can be great. For instance, the cost of rabies detection, prevention, and control in the United States is approximately $300 million annually.

Fish polymer baits containing 150 mg of rhodamine B will be used to conduct a field evaluation of rhodamine B. *(Photo by: P. Hill, NWRC)*

Rhodamine B as a Biomarker for Raccoons—In late 2006, NWRC researchers began an investigation of rhodamine B as an alternative biomarker to tetracycline in raccoons. Rhodamine B is a chemical dye that, when ingested, stains the oral cavity and is absorbed systemically in growing tissues (i.e., hair and whiskers), producing fluorescent orange bands under ultraviolet (UV) light.

In initial studies, rhodamine B marked all raccoons that consumed at least 100 mg of the dye. An average of 55 percent of whiskers sampled from each individual exhibited fluorescence for up to 13 weeks. The researchers used two methods to evaluate whiskers: a UV microscope and hand-held UV lights. Both methods were effective for detecting the fluorescence produced by rhodamine B dye, and thus would be satisfactory for use in the field evaluation of whiskers to provide almost instant information. The researchers also determined that raccoons did not exhibit a taste aversion to rhodamine B when it comprised less than 3 percent of a food source.



This whisker shows three fluorescent bands, indicating this raccoon consumed rhodamine B multiple times over a relatively short period. *(Photo by: P. Hill, NWRC)*

Use of a Genetic Analysis to Evaluate the Effect of a Natural Barrier to Prevent the Western Spread of Rabies—The primary means of controlling wildlife rabies in the United States is through an oral rabies vaccination (ORV) program using a recombinant vaccinia-rabies vaccine. This bait is distributed in oral baits targeting specific wildlife host species, principally raccoons and gray foxes. Understanding the spatial spread of rabies and of the host species is necessary for designing control strategies. The ORV program uses natural geographic barriers, such as mountains and large bodies of water, to help delineate ORV zones and slow the westward movement of raccoon rabies.

In Alabama, NWRC scientists collaborated with researchers from Auburn University to determine if gene flow occurred between raccoon populations across the Alabama River and thus determine whether this river served as a barrier to movement. The scientists employed 11 raccoon-specific microsatellite markers to obtain individual genotypes of 70 individual animals. The scientists examined if population differentiation among microsatellites was due primarily to distances between localities. They found that gene flow occurred across the river, and therefore, that both the dispersal of animals across the river and possible subsequent rabies transmission can occur. The spread of rabies across Alabama has been hindered, but this research indicates that the river is not the sole hindrance to the spread of rabies and that other landscape features still need to be investigated.

Feral swine feeding on Nilgai carcass. Nilgai, a native antelope of India, were introduced to South Texas in the 1930s on the King Ranch. *(Photo by: Jonathan Moczygemba, USDA)*

For more information on this project, contact Dr. Michael Dunbar at michael.r.dunbar@aphis.usda.gov

Title: Development of Surveillance Strategies and Management Tools to Control Pseudorabies and Other Wildlife Diseases That Affect Humans and Livestock

GOAL: To provide basic ecological information as related to developing management tools to control pseudorabies in feral swine and address other wildlife diseases (in particular, Texas cattle fever, Heartwater) that affect livestock

Invasive feral swine have been introduced into numerous countries where they cause significant damage to natural and agricultural resources. Population estimates of feral swine in Texas alone exceed 2 million. Feral swine also pose a major risk to the domestic swine industry due to their tendency to serve as disease reservoirs and their frequent contact with domestic swine.

Movements of Feral Swine Relative to Aerial Control in South Texas—Aerial control is widely used by private landowners and WS officials in Texas to reduce feral swine damage. However, no studies have been conducted on the impacts of aerial control on movements of surviving feral swine in

NWRC biologists swab a feral hog for Type A Influenza virus. Feral swine are susceptible to diseases that affect livestock, humans, and wildlife (e.g., brucellosis, pseudorabies, foot-and-mouth disease), provoking concern over the potential for disease risks associated with feral swine. *(Photo by: David Long, USDA)*

the United States. A scientist from the NWRC field station in Kingsville, Texas, conducted a study to evaluate whether aerial control of feral swine alters movements of surviving feral swine. The scientist placed Global Positioning System (GPS) collars on 13 feral swine on a property experiencing extensive damage in south Texas, just prior to the initiation of an aerial control exercise. These efforts, which included almost 6 hours of flight time, resulted in the removal of 151 feral swine on approximately 2,023 ha. Of the nine animals on site during aerial control, two males and two females moved outside their home range a mean distance of 1/2 a mile. However, all of these animals returned to within their home range the same day. A preliminary analysis of the results indicated only minor, short-term feral swine movements in response to aerial control. The results indicate that this technique may be useful in the event of a foreign animal disease outbreak.

Remote camera photograph of a feral hog picking up a scent station canister. Baits were flavored with five different flavors to determine which was the most attractive to the swine who visited the bait stations. *(Photo by: NWRC)*

A Genetic Evaluation of Feral Swine Ancestry in Texas—Feral swine descend from domestic swine that were released or escaped and have adapted to the wild. Feral swine have been present in the United States for over 200 years, but have recently increased dramatically in number. Texas has the largest population of feral swine, with current estimates at more than 1.5 million. Feral swine are susceptible to diseases that affect wildlife, livestock, and humans, raising serious concerns about the role of feral swine in the maintenance and transmission of disease. However, predictions of disease transmission by feral swine are hampered by a lack of information on their behavioral ecology. As a result, estimates of contact rates and other vital information for disease risk models and management are tenuous at best. NWRC biologists from the Center's Kingsville, Texas, field station collaborated with Texas A&M University as part of a graduate student project to investigate the mating behavior of feral swine as a means of estimating rates of contact among individual animals.

The biologists obtained tissue samples from free-ranging pregnant sows, extracted DNA, and constructed multilocus genotypes based on a panel of 12 DNA microsatellite markers. Biologists collected 64 tissue samples from pregnant sows containing 345 fetuses. They found evidence for multiple paternities in 21 of the 64 litters (33 percent). Most of the litters were from McMullen and San Patricio counties, with the animals having 38 percent and 39 percent of multiple paternity occurrences, respectively. The high rate of promiscuity (~33 percent of litters sired by >1 boar) suggests that the risk of feral swine transmitting diseases that are spread by direct contact (e.g., pseudorabies and brucellosis) is significant. These results demonstrate the value of molecular techniques in providing insight into difficult wildlife management problems and supply timely information for predicting disease transmission within feral swine.

Evaluation of Strawberry-Flavored PIGOUT® Baits for Feral Swine—Few studies have examined baits as oral delivery systems of biological agents to feral swine in the United States. Previous NWRC studies found that there was high removal and ingestion of both fish-flavored and vegetable-flavored PIGOUT baits by feral swine in southern Texas, but that non-target animals also removed and ingested the baits. NWRC scientists initiated research to identify swine-specific attractants as alternate bait flavors. The scientists identified strawberry flavoring as one such product that could be incorporated into a bait matrix intended for feral swine. They compared feral swine and non-target animal visitation, contact, and removal rates of five different PIGOUT bait treatments in southern Texas: (1) fish flavored, (2) vegetable flavored, (3) vegetable plus strawberry flavored, (4) vegetable flavored plus synthetic fermented egg, and (5) fish flavored plus synthetic fermented egg. The trials involved using an automated camera system to monitor baits hand-placed at 120 locations for each treatment. NWRC monitored the baits for up to 4 nights to determine species-specific visitation, contact, and removal rates. All treatment baits experienced unusually high removal by rodents.

AI in Wild Raccoon Populations—Raccoons are common, widespread, and mobile, and they frequently come into contact with wild waterfowl, agricultural operations, and human activity. NWRC scientists captured raccoons and analyzed blood samples to determine their exposure to AI. Serosurvey results showed that raccoons are exposed to AI virus and develop antibodies based on that exposure. The researchers found that antibodies to AI subtypes H10N7, H4N6, H4N2, H3, and H1 have a wide geographic variation in seroprevalence. Analyses of the cellular receptors for influenza virus revealed that raccoons have both avian and human type receptors. Experimental infection studies with captive raccoons confirmed that raccoons become infected with avian and human adapted influenza viruses, shed infectious virus, and can transmit virus to naïve raccoons. Accordingly, raccoons have the potential for co-infection with multiple subtypes of influenza viruses and genetic reassortment, which could possibly result in the creation of novel influenza strains.

Survival and Movements of Translocated White-Tailed Deer in Southern Texas—Translocation of white-tailed deer has become popular in southern Texas, yet its effectiveness for establishing populations in new areas is undocumented. NWRC biologists evaluated the survival, movements, and body condition of 51 white-tailed deer translocated into a partially fenced property (2,000 ha) and an unfenced property (4,000 ha) in south Texas. Cumulatively, 39 percent of all deer survived and remained on the release areas. Annual survival was lower (59 percent) in the partially fenced property compared to the unfenced property (74 percent). However, more deer left the unfenced property (60 percent) than the partially fenced property (15 percent). Young (1.5 to 3.5 years of age), translocated males had below average antler gain, body condition scores, and rump fat measurements as compared to native males. Results of this study give wildlife managers a basis for evaluating translocations as a tool to achieve their management goals.

For more information on this project, contact Dr. Tyler Campbell at tyler.a.campbell@aphis.usda.gov.

California ground squirrel. *(Photo by: John J. Mosesso, NBII)*

Invasive Species and Technology Development Research Program

The Invasive Species and Technology Development Research Program encompasses studies supporting pesticide registration, formulation chemistry, chemical analysis, benefit-cost analysis, population analysis, and wildlife contraceptive development. Additional research focuses on invasive vertebrate species.

TITLE: Economic Research of Human-Wildlife Conflicts: Methods and Applications

GOAL: Conduct applied economic assessments of human-wildlife conflicts involving damaging wildlife populations, invasive species and wildlife-transmitted diseases; develop improved methodology for assessing the benefits and costs of NWRC products and WS operations

The scope of wildlife damage management activities continues to expand as conflicts between humans and wildlife increase. NWRC economists seek to quantify the potential savings (benefits) and costs derived from mitigating the impacts of wildlife diseases; wildlife damage to agriculture, property, and natural resources; and wildlife risks to public health and safety.

Economic Analyses of Bird and Rodent Impacts to California Crops—California is the Nation's greatest agricultural producer. In 2006, California's gross value of agriculture production was nearly $38.9 billion. The 20 top California crop and livestock commodities accounted for more than 80 percent of the State's cash farm receipts, and 8 of these commodities grossed over $1 billion in receipts. The State ranks first in the Nation for the production of dozens of crops, such as avocados, grapes, and processing tomatoes, and it is also the sole producer of many U.S. crops, such as almonds, artichokes, figs, olives, and walnuts.

As part of a cooperative agreement with the California Vertebrate Pest Control Research and Advisory Committee, NWRC economists are evaluating the impacts of bird and rodent damage to selected county economies. Bird and rodent pests of California agriculture include crows, ground squirrels, house sparrows, and cottontail rabbits.

To date, economists have used a 3-step process to select 10 of 58 counties for input-output (IO) modeling: (1) identify counties that led the State in total agricultural production, (2) identify those counties that had the highest valued cash receipts from a set of 25 key crops, and (3) identify those counties that had the highest percentage or concentration of targeted crops as compared to total agricultural cash receipts. Based on this empirical scheme, the 10 counties receiving the greatest cumulative ranks in order are Monterey, Fresno, Ventura, Riverside, Kern, Tulare, San Joaquin, San Diego, Stanislaus, and Napa Counties.

NWRC scientists cooperate with Mexican cattle producers to assess impacts of vampire bat-transmitted rabies.
(Photo by: Luis Lecuona, USDA)

Estimating Economic Impacts of Vampire Bat-Transmitted Rabies in Mexico—Human population growth and movement into undeveloped areas of Mexico have created economically important interactions among agriculture, public health, and vampire bats. Vampire bat-transmitted rabies is a major cause of cattle mortality and human exposure to the disease in Mexico.

NWRC economists cooperated with scientists from APHIS' International Services Program in Mexico City and Mexico's Ministry of Agriculture, Livestock, Rural Development, Fisheries and Nutrition to examine the impacts of vampire bat-transmitted rabies to humans and cattle. They quantified the costs of mitigating rabies impacts through bat control and cattle vaccination programs and derived potential savings from decreased rabies infections. They then used this benefit-cost analysis to determine if the potential vaccination of cattle and control of bats in the vampire bat endemic region was economically efficient.

Scientists in Mexico place mist net to capture vampire bats.
(Photo by: Luis Lecuona, USDA)

Results showed that producers benefited from vaccinating cattle for rabies, with benefit-cost ratios between 3 and 15 for many realistic scenarios. Additionally, analyses showed that the regional Mexican economy was likely to gain an economic benefit of 5 to 25 pesos for every peso spent on vaccination and bat control.

Bioeconomic Evaluation of Feral Hog Damage in Congaree National Park, North Carolina—NWRC provided consulting services to the Wildlife Conservation Society (WCS) on how bioeconomic analyses can benefit seabird and sea turtle conservation. Of particular interest to the WCS was how to value endangered species and conduct benefit-cost analyses for control and eradication programs. Successes for management actions are usually measured in resource improvement, but the costs to carry out the management are measured in dollars.

The WCS is involved in invasive species eradication efforts to protect the nests of sea turtles and shorebirds and would like to show the economic benefits of their efforts relative to the costs. NWRC has used similar economic analyses to evaluate the results of predator control for protecting sea turtle nests on Florida beaches, and feral hog eradication and raccoon control on Cayo Costa Island, Florida, for protecting threatened and endangered sea turtles and shorebirds.

Economic Analysis of Invasive Monkey Damage to Commercial Farmers in Puerto Rico—Monkeys were introduced to supposedly secure locations in Puerto Rico beginning in the late 1930s and continuing through the 1970s. Almost immediately after the first introductions, monkeys began escaping into the wild on mainland Puerto Rico. Today, populations of two species, rhesus macaques and patas, are growing and have become threats to agriculture, human health and safety, and native wildlife. In particular, the damage monkeys caused to agricultural crops has become so severe that some farmers have switched from growing fruit and vegetables to using their land as pasture for grazing. Moreover, there is a high prevalence of herpes B virus among the rhesus macaques, which, while fairly benign in macaques, is approximately 70 percent fatal in humans. Between 1996 and 2004, the monkey populations were estimated to have quadrupled. NWRC and Florida WS worked in a cooperative effort with the Puerto Rican Department of Agriculture (PRDA) to assess the annual economic damage to commercial farmers from 2002 to 2006. During that period, the value of commercial farmers' losses to monkeys increased from more than $1.1 million to almost $1.5 million per year. More telling, much of the losses increased through time and could be attributed to farmers' giving up on growing fruit and vegetables due to monkey damage and switching to much less economically rewarding land uses, such as pasture land or growing hay. The economic losses included only commercial farmers (over 90 percent of all commercial farmers) that sought any form of assistance from the PRDA. Losses to small plot farmers and gardens were not part of the survey. Other economic losses, such as the value of lost endangered species, medical costs, or property damage due to monkeys, also were not included. The researchers predict that losses will continue to accelerate as the monkey populations continue to expand their range.

For more information about this project, contact Dr. Ray Sterner at ray.t.sterner@aphis.usda.gov.

TITLE: Methods and Strategies to Manage Invasive Species Impacts to Agriculture in Hawaii

GOAL: Develop safe and effective methods and strategies to manage the effects of invasive species to agriculture, natural resources, and human health and safety in Hawaii and other island ecosystems

Feral hogs in cattle area. *(Photo by: USDA WS CA)*

Grey francolin, an introduced species of partridge from south Asia, in Hawaiian seed corn field. *(Photo by: John J. Mosesso, NBII)*

Oceanic islands such as the Hawaiian chain are more susceptible to invasive species than mainland areas because islands have few predators or competitors, have significant air and sea traffic, and typically provide a favorable climate for many species. Furthermore, native species on the islands have evolved in the absence of many introduced threats and usually respond poorly to invasive animals or disease.

Invasive species are the single greatest threat to Hawaii's agricultural economy and natural environment and to the health and lifestyle of Hawaii's people. Invasive species cause millions of dollars worth of crop losses, the extinction of native species, the destruction of native forests, and the spread of disease, as well as reduce the health and safety of residents.

Bird Damage to Hawaiian Seed Crops—The NWRC field station in Hawaii conducts research to determine the extent of bird damage in seed crops and evaluate the results of an operational control program at a seed company on Maui. Production of seed corn and soybeans to breed and evaluate new strains has grown significantly in the Hawaiian Islands, and birds are considered a major source of seed loss, plant destruction, and potential movement of viable seeds to other areas. Depredation of individual plants can result in the loss of years of research effort costing millions of dollars. Currently, seed producers employ "bird chasers" to scare birds off seed fields. While effective, there is a need for less labor-intensive methods to protect seed crops.

NWRC scientists established experimental plots and performed observational bird counts to determine the nature and extent of the problem. Prior to NWRC's initiation of the operational control program, birds removed 71 percent of soybeans and 51 percent of corn seeds/seedlings in experimental (bird-exposed) plots. Black and gray francolins (pheasant-like gamebirds introduced from Asia) were responsible for most of the damage to sprouting plants. However, the most abundant bird species were rock doves (i.e., pigeons), spotted doves, and zebra doves. The thousands of doves in fields are a significant risk to plants and may also pose a disease risk to workers. The research results suggested an integrated management plan that included the operational removal of birds and the alteration of farm practices to reduce food and water sources for birds. After 9 months of the operational control program and the institution of changes in farm practices, there was a significant reduction in

Laboratory bioassays of commercial rodenticides conducted with Hawaiian rodents. *(Photo by: NWRC)*

the numbers of francolins and spotted doves. In experimental (bird-exposed) plots, birds removed less than 5 percent of soybeans and less than 4 percent of corn seeds/seedlings. The continued use of the operational control program and improved farm practices may greatly reduce the need for extensive use of bird chasers in fields.

Continued Evaluation of Commercial Rodenticides—Many rodenticides are commercially available nationwide, but their efficacy on wild roof rats, Polynesian rats, and mice commonly found in the Pacific basin is varied and frequently unknown. Currently, only three commercial rodenticide baits are registered for use in Hawaii to protect native plants and animals in conservation areas (diphacinone), reduce depredation in agriculture (diphacinone), and control rodent outbreaks for human health (zinc phosphide). Orchard managers for many of the emerging agricultural products (e.g., tropical fruits) have no registered rodenticides available to deal with rat and mouse damage.

Scientists at the NWRC field station in Hawaii completed a comprehensive laboratory study using a standardized protocol to determine the efficacy and palatability of nine commercial rodenticide bait formulations on Polynesian rats, roof rats, and house mice. During a three-tier series of feeding trials, rodenticides generally were more effective against mice than either of the rat species, and mice tended to eat more rodenticide bait than laboratory chow (control bait). Efficacy was generally greatest for the second generation anticoagulants Havoc® (brodifacoum), Maki® (bromadiolone), and Generation® (difethialone); however, the first generation rodenticide, Rozol® (chlorophacinone), had similar effectiveness. Palatability was least for the acute rodenticides. Rodenticide products currently registered for use in Hawaii were not as effective as some of the other products.

For more information on this project, contact Dr. Will Pitt at will.pitt@aphis.usda.gov.

TITLE: Resource Protection Through Avian Population Management

GOAL: Develop methods for the estimation of avian populations for species of WS management concern; develop and evaluate anti-fertility methods to reduce nuisance avian populations; evaluate the impact of management methods on targeted avian populations in support of efforts to reduce the negative impact of nuisance avian species on agriculture and property, human health and safety, and endangered species

Invasive Black Spiny-Tailed Iguanas Threaten Resources in Florida—The native range of the black spiny-tailed iguana extends from southern Mexico to Panama. The species was introduced into Florida around 1980 when three animals were brought from Mexico and released on the southern end of Gasparilla Island near Port Charlotte in southwest Florida. Since then, the species has spread to occupy the entire island, and with some human assistance, there are also iguana populations on the adjacent mainland, small islands nearby, and in Key Biscayne near Miami. Over the years, as the iguana population has grown, these lizards—once an interesting novelty—have become a serious problem. Residents of Gasparilla Island in both Lee and Charlotte counties have funded initiatives to control this invasive pest species, which eats valuable landscaping plants and occasionally enters buildings.

Black spiny-tailed iguanas also impact natural resources. Scientists suspect that the iguanas disperse seeds of non-native invasive plant species. They consume many native plants as well, including

some of the same food plants used by gopher tortoises, which are listed by the Florida Department of Environmental Protection as a threatened species. In addition, the iguanas occupy burrows made by gopher tortoises. The gopher tortoise is slow to reach reproductive maturity, produces small egg clutches, and grows slowly. Juvenile tortoises are vulnerable to predation for months after emergence.

In 2008, through an agreement with Charlotte County, APHIS biologists in Florida began to trap and remove iguanas on Gasparilla Island. Concurrently, using iguanas captured during the trap and removal operation, NWRC scientists in Gainesville, Florida, initiated research to identify a toxicant to augment the ctenosaur trapping effort. Furthermore, as WS trappers removed iguanas, NWRC scientists examined the carcasses to quantify body size, reproductive condition, and stomach contents. Analyses of stomach contents confirmed that iguanas are primarily herbivorous. However, they also appear to be opportunistically predatory, as indicated by the remains of a juvenile gopher tortoise found in the gut of a large male iguana. This is the first documented instance of such predation by iguanas on this State-listed threatened species. Scientists do not yet know the extent to which predation by the invasive black spiny-tailed iguana affects the gopher tortoise population on Gasparilla Island.

NWRC is using multiple monitoring methods that address the differing habitats and circumstances on the island to collect data for assessing iguana populations. One of these methods will be strip transects for iguana tracks to compare areas having received control to similar areas where control has not been initiated. NWRC scientists will also use tracking plots to establish baselines in dune areas prior to control and for comparison after control begins. They will also apply visual transects for the same purposes in residential areas and along rip-rap areas by the shore. Initial observations indicate the species could pose a threat to some snakes, which is of concern because indigo snakes are listed as a threatened species on the island. NWRC scientists

Black spiny-tailed iguanas are invasive on Gasparilla Island, Florida. *(Photo by: John J. Mosesso, NBII)*

Gopher tortoise. *(Photo by: Bruce Avera Hunter, NBII)*

On Gasparilla Island, black spiny-tailed iguanas often live in burrows constructed by the gopher tortoise, a threatened species in Florida. *(Photo by: E. A. Tillman, NWRC)*

are continuing to work with APHIS biologists and Charlotte County cooperators to eliminate threats posed by this invasive species.

Artificial Effigies Are Effective in Managing Urban Crow Roosts—In the United States, congregations of crows numbering in the tens of thousands have been documented for many years. A recent trend is for crow roosts to form in urban/suburban areas as opposed to rural sites. Roosting aggregations comprising thousands of crows have become familiar in towns and cities across the country. For the past several years, wintering crows have roosted in and around the city of Lancaster, Pennsylvania, to the consternation of Government officials, homeowners, and businesses. The Lancaster area is a matrix of residential communities, farmland, shopping centers, and industrial and light commercial development. In winter, crows use all of these areas for staging and/or roosting. Scientists from the NWRC field station in Florida evaluated the effectiveness of artificial effigies as a new technique for managing crow roosts.

While the use of effigies (i.e., dead crows) to affect crow behavior is not a new idea, there is divergent information as to whether or not crow effigies or carcasses actually are effective in disrupting crow behavior. Furthermore, no study had previously investigated the use of effigies specifically for dispersing crow roosts.

In 2006 and 2007, NWRC researchers installed effigies in trees and at ground level in sites where crows roosted. When necessary, they augmented the effigies using lasers and recorded crow alarm calls. Roosts were monitored before and after effigy installation, and crow numbers substantially decreased at the treated sites. The scientists concluded that effigies are potentially a valuable component of integrated roost dispersal programs.

In 2008, based on the findings of the first 2 years, researchers advised the Lancaster community-based crow roost dispersal effort on how best to implement harassment using effigies. This integrated dispersal effort resulted in approximately 35,000 crows being moved into an area where they were considered inoffensive to the community. The crows did not abandon the Lancaster area, but they ended up roosting at a location where their impact was negligible. The artificial crow effigy is a simple,

In the winter, large roosts of American and fish crows produce problems for many communities. *(Photo by: M. L. Avery, NWRC)*

inexpensive tool that has proven to be effective when applied in an integrated roost management approach.

For more information on this project, contact Dr. Michael Avery at michael.l.avery@aphis.usda.gov.

TITLE: Development and Assessment of Methods and Strategies to Monitor and Manage Mammalian Invasive Species with an Emphasis on Rodents

GOAL: Review the current biological status of established and potential invasive mammalian species, with an emphasis on rodents in the United States and its Territories, and investigate promising methods and strategies for surveillance, management, and eradication

Efficacy Trials to Identify Effective Rodenticides for Gambian Rats—NWRC researchers in Fort Collins, Colorado, completed a study of the effectiveness of several commercially available rodenticide baits on captive Gambian giant pouched rats. The objective was to identify a more effective rodenticide than the currently used zinc phosphide-grain bait for use in the management and eradication effort underway on Grassy Key in the Florida Keys. Two of the problems with the zinc phosphide-grain bait on Grassy Key are that (1) some rats will not enter the bait stations, and (2) others become bait-shy after consuming a sublethal amount of the bait. NWRC tested two formulations of diphacinone baits, one formulation of brodifacoum bait, and one formulation of zinc phosphide-grain bait in multiple-choice food trials. Neither of the diphacinone baits was effective; both the brodifacoum and zinc phosphide-grain baits resulted in 100 percent mortality. The NWRC researchers recommended the use of one or both of these latter two rodenticides in future Gambian rat control efforts.

Invasive Rodent Barriers Tested—NWRC scientists in Fort Collins completed a study of the effectiveness of geo-textile barrier materials made of metal fibers analogous to steel wool for preventing access by wild Norway rats and wild house mice to preferred foods. Such barriers could be used to prevent or reduce rodent access to resources, providing economic relief to humans and protection

Island vegetation with USDA field crew. *(Photo by: USDA)*

to natural resources. The barrier material evaluated in this study was highly effective in preventing both rodent species from traveling though holes in wooden walls. The barrier material is easily installed, allowing homeowners, food producers, and personnel of other industries to readily make use of them. However, when the researchers used 3×3-inch squares of geo-textile materials to cover the openings of food boxes, most rats and a few mice were able to breach the material and access preferred foods inside the boxes. Additional research is needed to identify inexpensive materials to prevent rodent access through sizable openings.

Effectiveness of Anticoagulant Rodenticides—NWRC researchers in Fort Collins completed a study with wild, invasive rodents to determine whether plants rich in vitamin K reduce the effectiveness of anticoagulant rodenticides. Rodents introduced to islands have caused the extinction of many species of animals. Wildlife managers rely on anticoagulant rodenticides to eradicate rodents from these islands, but question whether the rodenticide's effectiveness is reduced when rodents are eating plant materials that contain high amounts of vitamin K (an antidote to anticoagulants). During the study, NWRC fed Norway rats, roof rats, and house mice fresh collards and Brussels sprouts high in vitamin K. Ninety-four percent of the rodents NWRC subsequently presented with anticoagulant rodenticides (brodifacoum or diphacinone), along with a diet of plant material, died. The researchers concluded that the presence of plants high in vitamin K does not reduce the effectiveness of anticoagulant baiting programs for reducing populations of invasive rodents.

For more information on this project, contact Dr. Gary Witmer at gary.m.witmer@aphis.usda.gov.

Invasive Gambian giant pouched rats have been introduced to the Florida Keys. *(Photo by: USDA WS FL)*

TITLE: Development of Chemistry, Biochemistry and Computational Based Tools for Wildlife Damage Management

GOAL: Develop and apply chemistry, biochemistry, and computer modeling-based techniques and tools for improved management of pest wildlife by WS and the wildlife damage management community

Herbivore Avoidance of Protein Hydrolysates—Reports of casein hydrolysate avoidance in deer prompted NWRC chemists to evaluate how they can capitalize on this behavior to produce effective herbivore repellents from protein hydrolysates to reduce damage caused by a variety of species. Proteins, such as casein, are excellent sources of nitrogen and essential amino acids. Furthermore, as a component of mother's milk, casein is a critical component of mammalian diets early in life. Hydrolysis, a chemical or enzymatic process to break large proteins into smaller pieces, does not reduce the nutritional quality of proteins; rather, it often makes the proteins easier to digest. For this reason, casein hydrolysate is found in human infant formulas, diet supplements, and energy drinks. Yet, initial research with deer demonstrated that the animals avoided casein hydrolysate much more than the intact protein (casein).

NWRC's subsequent evaluation of several mammalian species to casein hydrolysate and gelatin (a hydrolysate of collagen) demonstrated a connection between the digestive strategy of the species and feeding response to foods treated with protein hydrolysate. Omnivorous mammals (consumers of plants and vertebrates or invertebrates) were indifferent to foods treated with protein hydrolysates, while strict herbivores (consumers of plants only) avoided foods treated with protein hydrolysates. NWRC researchers speculate that certain peptides resulting from protein hydrolysis have a particular meaning to herbivores that signal "do not eat," which may lead to a new type of effective repellent.

Development of a Pest Coyote Toxicant and Delivery Device—Coyotes cause significant damage to American agriculture, primarily through predation on livestock. Coyotes also attack pets and humans, collide with aircraft, depredate fruits and vegetables, cause damage to irrigation systems, prey on game species, and transmit zoonotic diseases. Ranchers and predation control specialists use a variety of techniques to minimize losses, including the broad-spectrum mammalian toxicants sodium cyanide and sodium fluoroacetate (Compound 1080)—the only oral toxicants registered for predator control in the United States. However, since 1998, California, Colorado, and Arizona banned the use of sodium

Eastern gray squirrel. *(Photo by: John J. Mosesso, NBII)*

cyanide and fluoroacetate for controlling livestock predators. As toxicants are a critical component of nearly all integrated pest management strategies, these bans severely restrict the ability of wildlife damage control specialists to limit coyote damage. NWRC researchers are collaborating with a variety of stakeholders to proactively develop safe and effective predator alternative toxicants.

Because the toxicity of chocolate to canids is well documented, NWRC chemists determined the optimal ratio of theobromine and caffeine—which are naturally occurring compounds in chocolate—to create a selective toxicant for canids. Collaborative studies conducted in California and Utah demonstrated that the Coyote Lure Operative Device (CLOD) can be used to deliver the theobromine:caffeine toxicant under field conditions. The results documented that, following consumption of the CLOD contents, mortality ensued with minimal pre-mortality symptoms. Molecular genetic analyses of accepted CLODs indicated that nearly all of the CLODs were activated by coyotes.

For more information on this project, contact Dr. Kathleen Fagerstone at kathleen.a.fagerstone@aphis.usda.gov.

TITLE: Development of Reproductive Control Methods for Overabundant Birds and Mammals

GOAL: Obtain U.S. Food and Drug Administration (FDA) approval for use of porcine zona pellucida (PZP) and gonadotropin-releasing hormone (GnRH) immunocontraceptive vaccines for white-tailed deer; develop new oral contraceptive agents for use in controlling reproduction in overabundant avian species, such as monk parakeets and crows, and in mammalian species, such as California ground squirrels and prairie dogs

Tree damage by squirrels. *(Photo by: USDA Forest Service, North Central Research Station)*

Squirrel Contraceptive Research at Clemson University—NWRC is collaborating with Clemson University to test a new gray squirrel contraceptive on campus. The lack of predators in the urban area has allowed squirrel numbers to increase and cause significant damage to trees and shrubs by gnawing and stripping bark. The Clemson campus landscape crews have documented more than 100 mature trees killed by squirrels, with an additional 100 trees severely damaged. The study is evaluating the effectiveness of the contraceptive GonaCon™, which is injected into both male and female squirrels and causes infertility after just one treatment. About 40 squirrels have been trapped, tagged, injected with GonaCon, and released. Another 40 squirrels have been trapped, tagged, and then released as a control group. The health, sex, and age range of each animal will be recorded and their reproduction rate monitored next spring.

Prairie Dog Contraception—Prairie dog colonies across the Front Range of Colorado have expanded to the point that they have denuded the landscape, particularly suburban settings. Conflicts about how to manage prairie dog colonies in urban areas have become more common between resource managers who must manage natural areas to maintain native plant life and residents who oppose lethal control of colonies. In October 2006, NWRC scientists initiated a study in Larimer County, Colorado, to evaluate the feasibility of using GonaCon as a nonlethal management tool for black-tailed prairie dogs in urban and suburban settings. Prairie dogs were captured on control and treatment sites, weighed, sexed, and marked with eartags and fur dye. In addition, each captured prairie dog was vaccinated with either a sham vaccine or GonaCon.

Beginning in May 2007, prairie dogs were recaptured at both sites to determine breeding status and to collect blood samples for analysis of anti-GnRH antibody titers. Pup counts were also conducted during May and June 2007. A second year of data was collected during the summer of 2008 to determine the vaccine's longevity. All treated animals recaptured during the first year were infertile. Only a small percentage of treated animals could be recaptured in 2008. Of the six treated animals that had retained eartags, half were still infertile.

In addition to the GonaCon study, NWRC scientists initiated another study in November 2007 to evaluate DiazaCon™, an oral reproductive inhibitor for prairie dogs. Rolled oats coated with DiazaCon and molasses were fed to the prairie dogs for 10 days during November 2007. Pup counts were conducted in June 2008. Preliminary data show a 98-percent reduction in the numbers of pups per adult.

Elk Contraception Tests in Rocky Mountain National Park—Unregulated concentrations of elk have become a significant problem for resource managers in Rocky Mountain National Park (RMNP). An NWRC scientist is collaborating with researchers from Colorado State University (CSU) on a 3-year study to evaluate the efficacy and safety of the immunocontraceptive vaccine GonaCon as a potential management tool for reducing populations and controlling reproduction of free-ranging female

Prairie dog contraception. *(Photo by: Jim Gionfreddo, NWRC)*

Biologists inject tranquilized elk in Rocky Mountain Park with GonaCon contraceptive. *(Photo by: USDA, NWRC)*

Plastic tube for delivering baits to brown treesnakes. *(Photo by: Ken Tope, NWRC)*

elk in RMNP. One hundred and twenty elk (60 treated with GonCon: 60 control) were captured and radiocollared during January 2008. Beginning in January 2009, 40 elk (20 treated: 20 control) will be recaptured and euthanized each year for the next 3 years to evaluate the effective duration of GonaCon on elk reproduction. Postmortem examination of the reproductive tract of each animal will be conducted at CSU's Veterinary Diagnostic Laboratory in Fort Collins, Colorado.

For more information about this project, contact Dr. Lowell Miller at (970) 266–6163 or lowell.a.miller@aphis.usda.gov.

TITLE: Chemical Control for Brown Treesnakes: Methods and Applications

GOAL: Develop chemicals (toxicants, lures, and attractants), baits, and delivery methods for integrating into WS operational control of brown treesnakes (BTS) in Guam

BTS were accidentally introduced to Guam in the late 1940s or early 1950s and have caused extensive economic and ecological damage to the island. In just half a century, the BTS has exterminated most of Guam's native forest birds and greatly reduced its population of fruit bats and native lizards. WS actively manages BTS populations on Guam to prevent their spread to other Pacific islands, especially Hawaii. BTS research is a reimbursable-funded project initiated in 1995 and was assigned as an official project under the Hilo, Hawaii, field station in October 2007. The majority of the funding has been provided by the U.S. Department of Defense (DoD) Legacy Resource Management Program, the U.S. Department of the Interior's (DOI) Office of Insular Affairs, DOI's Fish and Wildlife Service, and WS Operations.

Paper Flags for Aerial Delivery of Baits to BTS—NWRC scientists continued developing a system for the aerial delivery of baits to BTS in forested areas of Guam. The overall goal of this work is to improve the delivery of acetaminophen baits to snakes in the forest canopy.

NWRC scientists attached dead neonatal mice (DNM) to commercially available, biodegradable paper flags that were deployed either by an automated–electromechanical dispenser or by hand

Helicopter with dispensers for aerial delivery of dead mouse flag-baits to brown treesnakes. *(Photo by: Ken Tope, USDA)*

from a helicopter on a 4-ha forest test site. They conducted 6 drops, 3 each by dispenser and hand; 28 of the 144 DNM flag-baits deployed per drop had a radio transmitter attached to the DNM for tracking purposes. Acceptance of the DNM was not a priority, and NWRC made attempts to recover all radios on the day of deployment.

The overall performance of both aerial delivery systems was successful. Eighty-five percent of the radioed DNM deployed by dispenser and 79 percent of the DNM deployed by hand got caught up in the canopy where they were accessible to BTS. NWRC deployed a total of 168 radioed DNM, 150 of which were recovered the same day and 18 of which were found the following day. Of these 18, snakes had consumed 5 DNM, and a marine toad ingested 1.

NWRC identified two modifications that are needed to improve the aerial delivery system: (1) paper flags that are more resistant to water, as the current flags degraded and dropped the DNM to the ground when it rained, and (2) the use of a paper flag on each end of the streamer so that a loop is formed in the air, increasing entanglement in the canopy.

Evaluation of Alternative Baits for Brown Treesnakes—Initial bait studies done with BTS used DNM as the matrix for the oral toxicant (acetaminophen) for BTS. Although DNM are well accepted by BTS, the mice are expensive and become putrid after 2 to 3 days in the field. NWRC scientists are conducting research to develop a bait that is an effective alternative to DNM.

NWRC scientists conducted field studies in April (dry season) and August (wet season) 2007 to evaluate the consumption of 5 baits for delivering acetaminophen to brown treesnakes on Guam. Test baits were placed in bait stations (polyvinyl chloride tubes) with a bolt secured halfway across each end to mitigate access by non-target animals. Bait stations were positioned horizontally about 1.5 m high in vegetation at 20-m intervals along the forest perimeter adjacent to roads and trails. Bait types were randomly assigned to bait stations and included DNM, dehydrated DNM, freeze-dried DNM, unadulterated beef, and beef treated with the decomposition products of uDNM that had “aged” under field conditions for 48 hours. Bait consumption for the beef treated with “aged” DNM was as high as 93 percent, comparable to untreated DNM. Results from both seasons suggest that decomposition odors of dead mice can be used to substantially increase BTS bait consumption of beef. NWRC will direct future studies towards the evaluation of synthetic bait matrices treated with decomposition products of “aged” DNM.

For more information on this project, contact Dr. Peter Savarie at peter.j.savarie@aphis.usda.gov.

Preparing to apply rodenticide bait during a WS/FWS rodent eradication effort on Mokapu Island, Hawaii. *(Photo by: USDA)*

Program Support—Registration Highlights

The NWRC Registration Unit is responsible for ensuring that registrations of our chemical-based tools are current and meet State and Federal regulations. The NWRC Registration Unit works closely with APHIS' Policy and Program Development/Environmental Services office in all product registration activities. APHIS continues to hold registrations with the U.S. Environmental Protection Agency (EPA) for rodenticides, predacides, avicides, repellents, snake toxicants, and an avian repellent. APHIS also holds Investigational New Animal Drug (INAD) applications with the FDA for immobilizing agents. In addition, the Registration Unit is working on product registrations through the EPA for a contraceptive to be used on wild and feral animals. To maintain or expand authorized use of these products, the Registration Unit works closely with NWRC scientists to ensure that studies conducted for regulatory purposes meet EPA and FDA guidelines.

The Registration Unit also provides technical assistance and information to APHIS' State WS offices, Federal and State agricultural and conservation agencies, academic institutions, non-governmental groups, and private industry. This work often includes responding to requests for regulatory assistance from Federal and State agencies, in addition to WS. Many of the requests for assistance come from WS operations personnel seeking new products or improvements to existing products, or looking for help in interpreting product labels to ensure proposed applications are legal.

Pesticides

New APHIS Pesticide Product Registrations—APHIS currently holds registrations through the EPA for 10 active ingredients formulated into 23 federally registered vertebrate pesticide products. These products meet the management needs of birds (5 avicides and 1 avian repellent), rodents (11 rodenticides and one burrow fumigant), predators and livestock protection (2 predacides and 1 fumigant), and BTS on Guam (1 toxicant).

APHIS registered two new rodenticide products through the EPA in 2007 with the assistance of FWS and a non-governmental organization. These products, "Brodifacoum-25W Conservation" (EPA Reg. No. 56228-36) and "Brodifacoum-25D Conservation" (EPA Reg. No. 56228-37), are intended to be used for conservation purposes, specifically the eradication of invasive rodents on islands and unmanned derelict ships. The State of Hawaii granted a State registration for "Diphacinone-50 Conservation" in 2007, and WS and FWS conducted an eradication project on Mokapu Island in February 2008. Rodent monitoring on the island will continue for 2 years to ensure the eradication effort was successful. The State of Alaska approved the registration of "Brodifacoum-25W Conservation" to conduct a rat eradication project on Rat Island in the Aleutian Islands in September 2008. These two new products, along with "Diphacinone-50 Conservation" (EPA Reg. No.

56228-35) registered in June 2007, are vital tools in the efforts to protect native wildlife on islands from invasive rodents.

In addition to the new labels for rodent eradication using anticoagulant rodenticides, the NWRC Registration Unit assisted WS in obtaining an EPA Emergency Use Permit to use a new zinc phosphide formulation to eradicate Gambian pouch rats from Grassy Key in Florida. This project was the first eradication effort against the Gambian pouch rat in the United States and utilized special bait stations because the effort was conducted in a densely populated area.

The California Department of Food and Agriculture (CDFA) requested that APHIS modify the "Zinc Phosphide Concentrate" label (EPA Reg. 56228-6) to help control California voles in artichoke fields. In a cooperative effort, the CDFA provided all of the data needed to ensure product efficacy and worker safety, and APHIS submitted a label amendment request to EPA in 2007 that was approved in March 2008. In addition to this label modification, APHIS submitted a request to EPA to allow use of this product in food and feed crops, including alfalfa, barley, dry beans, sugar beets, and wheat.

Wildlife Contraceptives

NWRC is a world leader in the development of effective wildlife contraceptives. The first APHIS contraceptive positioned for registration with the EPA is GonaCon™, an immunocontraceptive vaccine based on gonadotropin-releasing hormone. GonaCon is the first immunocontraceptive vaccine to provide multiple years of infertility following a single injection. NWRC's Registration Unit will soon submit the registration application for controlling fertility in white-tailed deer to the EPA. The Registration Unit has also worked closely with NWRC scientists and cooperators to field test GonaCon in prairie dogs and tree squirrels. If successful, NWRC may seek EPA registrations for these species.

APHIS has two EPA Experimental Use Permits (EUPs) to test GonaCon in other cervid species, such as deer and elk. EPA approved an EUP in July 2007 for a study NWRC is conducting in cooperation with the U.S. National Park Service (NPS) at Point Reyes National Seashore in California. The purpose of the study is to evaluate the efficacy of GonaCon on fallow deer. EPA approved another EUP in November 2007 for NWRC to test GonaCon in elk in the RMNP. The testing of GonaCon for reproductive control of overabundant elk is one part of a study to manage elk population health and abundance in the RMNP. This study is a cooperative effort among NWRC, CSU, and the Colorado Division of Wildlife.

Predacide Petition Under Consideration with EPA

In November 2007, the EPA sought public comment on a petition the agency received to cancel the registrations for sodium cyanide and sodium fluoroacetate for predator control. WS is authorized by Congress to manage a program to reduce human/wildlife conflicts, including depredations by livestock predators. Currently, WS uses sodium cyanide capsules in M-44 devices and sodium fluoroacetate (Compound 1080) in the livestock protection collar (LPC) as tools in an integrated wildlife damage management (IWDM) program, primarily to control predators impacting livestock production.

To provide input on the petition, APHIS assembled a task force to prepare a comprehensive WS response. The task force was led by APHIS WS Operational Support staff and included representatives from WS Operations, USDA's Agricultural Research Service, and APHIS Policy and Program Development. The response submitted to EPA detailed the IWDM program, compliance and recordkeeping, WS use patterns of M-44s and LPCs, the economics of predator management, and human and pet health and safety as it relates to M-44 and LPC use. The NWRC Invasive Species and Technology Development (ISTD) Program, including the Registration Unit and the Economics Project, provided evaluations of the health and safety and economic impacts of M-44 and LPC use. APHIS expects an EPA decision on this petition by the end of 2008.

For more information on this project, contact John Eisemann at john.d.eisemann@aphis.usda.gov.

Providing Wildlife Services

Crested Auklet, Kiska Island, Alaska.
(Photo by: F. Deines, FWS)

NWRC works with international, Federal, State, university and private partners to find solutions to human-wildlife conflicts.

National Support

Alau Islet Bird Sanctuary Rodent Survey—Alau Islet is one of eight offshore-managed State seabird sanctuaries in Hawaii that are home to a large number of endemic plants, insects, birds, and marine creatures. Eight threatened and endangered species and eight "Federal species of concern" are currently present on these islets. Because rodents have been a major factor in the extinction or extirpation of birds and other unique island species from many Pacific islands, wildlife managers will target rodents on Alau Islet for eradication efforts. In October 2007, researchers from the NWRC field station in Hilo, Hawaii, met with Hawaii State Department of Land and Natural Resources Natural Area Reserve System (NARS) biologists on Maui to coordinate a rodent census on Alau Islet, a craggy 13-hectare seabird sanctuary located east of Maui Island. NWRC provided training to NARS and Maui Invasive Species Committee personnel on setting up rat traps and tracking stations to index rat activity. NWRC researchers also demonstrated protective measures that can be used to minimize nestling seabirds exposure to rodents. NARS will be checking and monitoring the traps and stations to gather population data.

Scientists Advise Puerto Rican Officials on Invasive Monkeys—Rhesus and patas monkeys were originally brought to Puerto Rico research facilities. Escaped animals have established expanding, free-ranging breeding populations that now threaten agriculture and human health. The Puerto Rico Department of Natural Resources (PRDNR) and Puerto Rico Department of Agriculture (PRDA) requested assistance from WS in its development of an environmental assessment for control of these

Terns on Bird Island, Hawaii. *(Photo by: James P. McVey, NOAA)*

invasive species. During November and December 2007, NWRC biologists from the Gainesville, Florida, field station and Florida WS met with their PRDNR counterparts to assess human health risks and provide advice on study designs to monitor movement of exotic monkeys. The biologists visited various PRDNR facilities, met with project staff, and spent several days assisting with radio-collar attachment, monitoring monkey activity, and providing technical advice on trap design and potential bait screening.

Scientist Serves as Project Reviewer for Rodent Eradication in Aleutian Islands—An NWRC scientist in Fort Collins, Colorado, was invited in November 2007 to be an external advisor/reviewer to a consortium preparing for large-scale invasive rat eradications in the Aleutian Islands. The scientist is serving on a committee set up to oversee the planning and implementation of an aerial broadcast-baiting of Rat Island using the rodenticide brodifacoum. The 10.3-square-mile Rat Island is part of the Alaska Maritime National Wildlife Refuge. The island became infested with Norway rats after the shipwreck of a Japanese vessel in 1780. The rats on this island and other Aleutian Islands have caused significant declines in ground-nesting seabird populations. Rat Island will serve as a test case for other eradications in less isolated settings. The NWRC scientist helped conduct a trial eradication of Norway rats on Kiska Island and assisted in developing a strategy that has been used to eradicate rats successfully from several Caribbean Islands.

Biologist Presents Research Findings at Boeing—A biologist from the NWRC field station in Sandusky, Ohio, attended a meeting in December 2007 at Boeing's Integrated Research and Development Product Development Enhanced Technology Systems Concept Center in Everett, Washington. The purpose of the meeting was to discuss the possibility of reducing bird-aircraft collisions by enhancing the birds' detection of aircraft. The scientist, along with co-investigators from California State University, Long Beach and Precise Flight, Inc. (Bend, Oregon), presented research findings on bird avoidance responses to lights and approaching vehicles. The results were from a field trial with a commercial airline, and the trial was based on earlier research efforts at the NWRC field station. Boeing engineers, a representative from a major commercial airline, and customer of Boeing were present at the meeting.

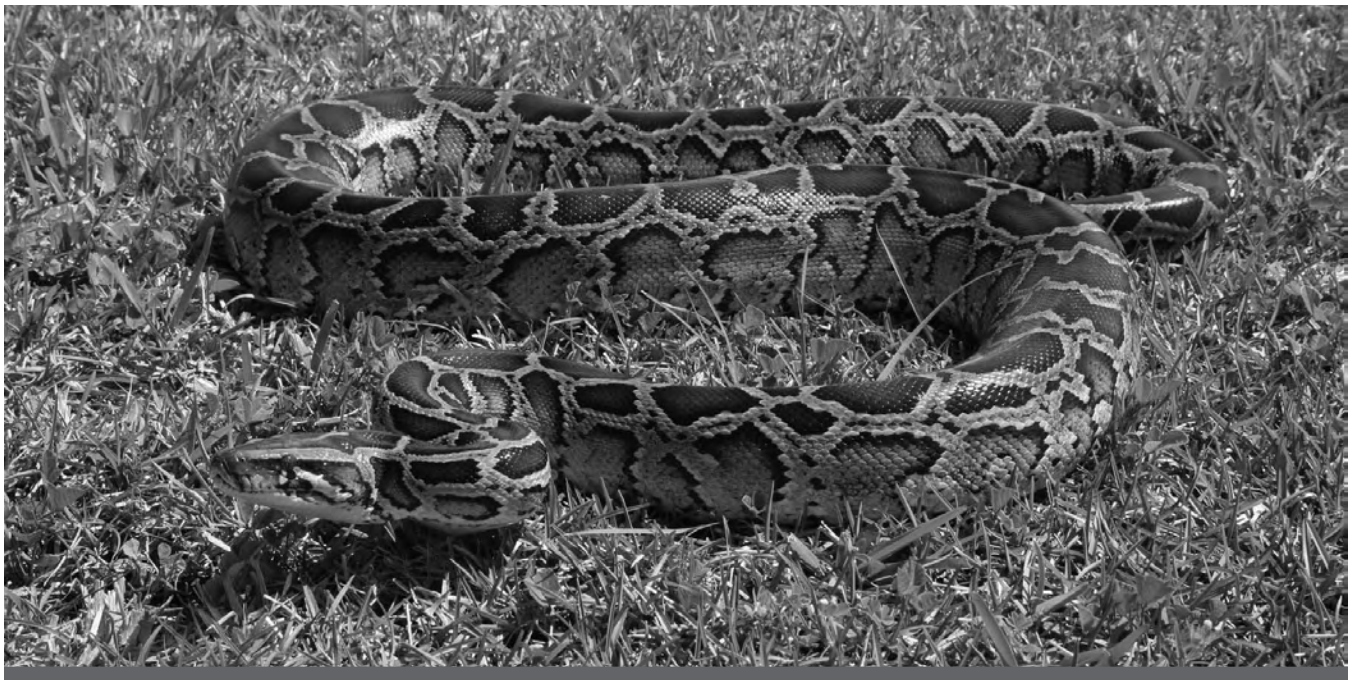
Evaluating the Efficacy of Spay/Neuter Programs in Colorado—The Animal Assistance Foundation (AAF) has funded spay/neuter programs in Colorado for over 30 years. In January 2008, an NWRC researcher met with AAF representatives to assist in designing studies that evaluate the efficacy of spay/neuter programs for reducing the number of free-roaming dogs and cats in the State. The AAF plans to assess spay/neuter programs in 2008 in three matched rural communities in eastern Colorado. Each of the three communities will either serve as a control (no spay/neuter program), receive a spay/neuter program in year 1, or receive a spay/neuter program in years 1 and 2. This study not only will assess program efficacy, but also will evaluate the longevity of efficacy over the course of at least 4 years of observation. This study will match communities based on characteristics such as size, animal shelter intake, and surrounding land uses. The variables the studies will measure include animal shelter intake rates and euthanasia rates, as well as indices of free-roaming dogs and cats.

WS Participation in a Workshop Addressing the Burmese Python Threat in Florida—Researchers from the NWRC field station in Gainesville, Florida, and Florida WS attended the "Addressing the

Python Threat: Setting Priorities for Action" interagency workshop in January 2008. More than 30 managers and experts from Federal, State, and local government agencies, nonprofit conservation organizations, and universities collaborated to prioritize the work needed to address the python threat and formulate an action plan, with the objectives of controlling and containing the current python population in south Florida and deterring additional introductions. The Burmese python is the world's sixth largest snake and may grow to over 20 feet in length. Along with the alligator, it has become a top-order carnivore in the region around Everglades National Park and is spreading northwards, as well as to Key Largo in the south. The snake is primarily a threat to native species, including many federally listed threatened and endangered species. Two-thirds of the Burmese pythons found on Key Largo have eaten highly endangered Key Largo woodrats. The python also poses a threat to human health and safety, either through direct encounters or indirect means (i.e., causing automobile accidents).

The workshop participants identified two top planning items: (1) to prepare a strategic plan that addresses the pythons on Key Largo, and (2) to develop an environmental assessment (EA) for general control. The top two control issues they identified were to develop a rapid response team for large constrictor sightings and to initiate control on the mainland python population. The participants also identified their top two research priorities—trap development and the development of pheromone attractants. A National Park Service representative at the meeting brought recently caught pythons for the NWRC staff to take back to the Gainesville field station for use in pheromone experiments.

NWRC Scientist Assists in Airport Vegetation Management Recommendations—The Illinois Department of Transportation (IDOT) is preparing a "Best Management Practices" report for Illinois airports, including recommended seed mixtures for airfield revegetation projects. In February 2008, biologists from the NWRC field station in Sandusky,



Burmese python. *(Photo by: NPS)*

Ohio, and Illinois WS met with officials from the IDOT's Division of Aeronautics in Springfield, Illinois, to present findings from recent NWRC studies regarding airfield vegetation management and Canada geese foraging preferences. WS also provided current information and assisted in the development of these guidelines.

Economic Evaluation of Endangered Species Conservation Through Invasive Species Eradication—The Wildlife Conservation Society (WCS) is involved in invasive species eradication efforts to protect sea turtle and shorebird nests. WCS would like to show the economic benefits of its efforts relative to the costs and how to value endangered species and conduct benefit-cost analyses for control and eradication programs. Successes for WCS management actions are usually measured in resource improvement, but the costs to carry out the management are measured in dollars. In February 2008, an NWRC scientist advised a WCS representative on economic analyses for seabird and sea turtle conservation through predator removal. The NWRC scientist explained the economic analyses for predator control for protecting sea turtle nests on Florida beaches. NWRC and WCS also discussed the approaches used in evaluating feral hog eradication and raccoon control on Cayo Costa Island, Florida, to economically assess the positive nesting results for threatened and endangered sea turtles and shorebirds.

Reducing Wildlife Hazards to Aviation Posed by Stormwater-Management Facilities—The Federal Aviation Administration (FAA) is interested in drafting new management guidelines for stormwater runoff on airport properties and within the 10,000-foot siting criteria for airports serving turbine-powered aircraft. In September 2008, a scientist with NWRC's field station in Ohio and the Alabama WS State Director collaborated with Auburn University faculty members and FAA representatives to initiate a study at Auburn University related to the planned management guidelines. In this study, they constructed a model stormwater-retention pond and investigated physical modifications, biotic and synthetic water-treatment methods, and hydrology scenarios to treat run-off while minimizing birds' use of the pond. This study is a companion effort to another study that has been in progress at Auburn University since December 2007, which involves the same collaborators and will develop predictive models of stormwater-retention pond features that contribute to avian use. Notably, both of these studies stem from recent research conducted by the scientist with the NWRC field station in Ohio, WS biologists in Washington, and FAA officials, in which they modeled avian use of stormwater-detention facilities common to airports in the Pacific Northwest. The research studies at Auburn University are the first to incorporate both wildlife and engineering components to reduce wildlife hazards posed by stormwater-management facilities on and near airports.

Monitoring Feral Swine For Assessing the Risk of Disease Transmission to Domestic Stock—North Carolina is of national significance to the pork industry, as this State produces the second highest number of swine in the United States. The introduction of a disease such as pseudorabies or brucellosis into the domestic swine industry through feral animals could have severe economic repercussions. NWRC is collaborating with North Carolina WS and North Carolina Department of Agriculture (NCDA) personnel to develop methods for monitoring and indexing feral swine populations. The resulting information will be valuable for assessing the risk for disease transmission to domestic hog farms. This collaborative effort in North Carolina has

resulted in a number of practical in-field designs for gathering information to evaluate current risks and trends in risks for hog farms from feral populations. The researchers will conduct indexing and swine sign surveys three times per year. Because the North Carolina feral swine populations are in the initial stages of their growth curve, these data will be invaluable for documenting seasonal and time trends for feral swine and optimally focusing management strategies and actions.

NWRC Evaluates Contraception of Fallow Deer at Point Reyes National Seashore (California)—Fallow deer, which are native to Europe and Asia, were introduced in the Point Reyes area during the 1940s and 1950s and are now causing extensive ecological damage. In a collaborative study with the NPS at Point Reyes, NWRC has been studying the reproductive status of female fallow deer. In July 2007, researchers treated 69 female fallow deer with a single-injection immunocontraceptive vaccine, GonaCon, under an approved management plan for non-native deer populations at Point Reyes. In June 2008, they observed deer for 5 days to determine fawning rates of treated and control animals during the first year of this 2-year study. A combination of removal and contraception will be used to reduce the fallow deer population at Point Reyes to zero by 2021. Scientists hope that damage caused by these deer at Point Reyes can be reversed once the animals have been removed from the seashore.

A Simulated Emergency-Response Depopulation Effort Targeting White-Tailed Deer—NWRC researchers coordinated an effort involving FWS and University of Nebraska-Lincoln collaborators to conduct a simulated depopulation of a white-tailed deer herd in July 2008 at the Desoto National Wildlife Refuge in western Iowa. This effort was the final evaluation in a study to determine if a disease outbreak could be quickly and effectively contained and managed with a quick-to-erect temporary fencing strategy. Researchers used paintball guns in a coordinated drive to mark individual deer within the 104-acre experimental enclosure and simulate depopulation. The interagency collaboration evaluated another potential tool in wildlife disease management.

Common myna. *(Photo by: Shiva Shankar, Bugwood/USFS)*

Controlling Invasive Mynas in American Samoa—Common mynas were introduced into the Pacific Islands in the early 20th century as a biocontrol tool for insects. Mynas have spread throughout the islands and are now considered a pest that has caused the decline of native birds and damage to fruit crops. During August 31 through September 4, 2008, NWRC scientists from Fort Collins, Colorado, and Gainesville, Florida, traveled to American Samoa (AS) at the request of the AS Department of Marine and Wildlife Resources (DMWR) to consult on the control of invasive mynas. NWRC personnel observed myna feeding flocks and discussed management options with DMWR officials. They also held a meeting with the local EPA office to discuss potential myna control strategies on AS. In collaboration with DMWR, NWRC and EPA developed a plan for obtaining a Section 3 Federal registration for the use of DRC–1339 to control mynas as part of an integrated management strategy on AS. During the next year, NWRC and DMWR will work together

to accomplish the training and data collection activities EPA requires for the Section 3 registration specific to mynas. If the project goes as planned, operational use of DRC-1339 in AS could occur in as little as 2 years.

International Cooperation

AI Surveillance Program in Kenya—The global spread of HPAI H5N1 has caused considerable concern about the potential of a human pandemic. Although controlling HPAI H5N1 in Asia has received considerable attention, there has not been as much focus on the HPAI situation in Africa to date. However, Africa may be a significant area of future concern, as there is great potential for HPAI H5N1 to be widely introduced into this country due to wild birds migrating to Africa from Europe (where HPAI H5N1 is already present), exponential increases in the country's human population densities, and the country's very high levels of human contact with poultry.

Currently, surveillance for HPAI H5N1 in Africa is sporadic, with few, if any, rigorous sampling programs in place. In collaboration with the U.S. Army Medical Research Unit-Kenya, NWRC wildlife disease scientists are establishing a surveillance program to detect HPAI H5N1 virus in feces from migratory wild birds passing through and wintering in Kenya. NWRC staff are developing and implementing a low-cost AI surveillance program in wild birds for Kenya using avian fecal samples and, eventually, water. This transfer of technology will include developing a sampling design based on existing information that identifies primary aquatic areas used by migratory waterfowl, provides field collection methods to collect 5,000 wild bird fecal samples at the key areas identified, trains Kenyan personnel in assays developed at NWRC to detect AI virus from collected samples, and develops and manages a laboratory database for surveillance. Part of this effort will also serve as a M.S. project for a Kenyan student. In addition, scientists will initiate water sampling as technology becomes further refined in the EEVB Project (see "Ecology of Emerging Viral & Bacterial Diseases in Wildlife [EEVB]" project description).

Canadian Scientists Visit NWRC to Discuss AI Surveillance—In December 2007, two Canadian scientists visited the NWRC to discuss AI surveillance activities in Canada and potential future collaborations on AI research and surveillance between Canadian and U.S. scientists. They met with researchers from both NWRC and WS' National Wildlife Disease Program. Part of the collaboration discussed included supplying samples collected in Canada for genetic sequencing at NWRC to support a national risk assessment for the introduction of HPAI into the United States. Scientists from the NWRC and APHIS' National Wildlife Disease Program are collaborating with CSU researchers to conduct this risk assessment.

Indexing Dingoes and Co-Existing Species in Queensland, Australia—An NWRC researcher is collaborating with a researcher from the Queensland Department of Natural Resources and Mines (DNRM) to calculate passive tracking indices (PTI) for dingoes and 19 co-existing species from 3 shires in Queensland. The researchers have collected data in each of the 3 shires for 4 years. They will calculate PTI values for both baited and unbaited areas within each shire before and after the baiting programs. The results will help discern the effects of the bait programs on dingo populations, the programs' effects on other species, and the effects of dingo removal on the other species.

Collaboration in Australia to Evaluate Mark-Recapture Population Estimations—Mark-recapture is the most common method in wildlife research and management for estimating the abundance of small mammal populations. As part of an ongoing collaboration on mark-recapture estimation, an Australian government researcher with Commonwealth Scientific and Industrial Research Organization (CSIRO) is working with an NWRC statistician to evaluate mark-recapture results and lessons learned from an intensive, multi-year rodent study on Bribie Island, Australia. The two researchers are working to produce an extensive manuscript detailing the sensitivity of mark-recapture population estimation to violations of its calculation assumptions. The study has shown this high-labor method to be very sensitive to violations of its assumptions. Mark-recapture requires much caution in its application and particularly in the acceptance of its results. This study has shown that the method can be tenuous, even under seemingly ideal circumstances.

Valuing and Investing in People

Grapes.
(Photo by: Patrick Tregenza, USDA)

NWRC values and invests in its employees to support their professionalism, competence, and innovation as Federal leaders of wildlife damage management.

Awards and Training

Wildlife Services 2008 Administrative Employee of the Year Award—NWRC Budget Analyst Cherryl Tope has been awarded the WS Administrative Employee of the Year award. Ms. Tope has worked for the NWRC for almost 11 years, during which time she has consistently performed her job in an exceptional manner. She began working as a budget analyst for the NWRC in 2005. Her job performance in this capacity has exceeded the expectations of everyone who has worked with her. Ms. Tope has shown exceptional professionalism, competence, and courtesy in dealing with everyone she works with, and her dedicated efforts have enabled her to make significant contributions to the WS program. Her attitude and enthusiasm create positive interactions and an enjoyable work environment, enhancing NWRC productivity and creating favorable perceptions of WS by other Government employees, cooperators, and the general public. The most impressive characteristics Ms. Tope possesses are her courtesy, tact, and willingness to provide customer service. This award was established to recognize the outstanding contributions of WS administrative employees.

NWRC Researcher Nominated for Florida "Agency Accomplishment" Award—The Florida Department of Environmental Protection (FDEP) nominated Dr. Rick Engeman and his co-researchers for Florida's "Agency Accomplishment" Award based on their work with the FDEP on boat damage to seagrass beds. Protection of seagrass beds from damage is one of FDEP's top conservation priorities, and Dr. Engeman provided statistical and economic analyses of boat damage to seagrass beds in Lignumvitae Key Botanical State Park.

Risk Communication Training—In April 2008, several NWRC scientists participated in a 2-day course in Fort Collins, Colorado, to enhance communication skills with the media and public during crisis or emergency situations. The course included an overview of risk communication theory and message preparation, as well as mock on-camera interviews. APHIS is an emergency response agency and often calls upon its scientists to serve as first responders during natural emergencies or disease outbreaks. The course was hosted by APHIS Legislative and Public Affairs.

WS Immobilization and Euthanasia Certification Course—In June 2008, NWRC hosted a 3-day course in Fort Collins, Colorado, to certify WS personnel in chemical immobilization and wildlife euthanasia. This course included 24 hours of instruction and hands-on laboratory exercises involving all aspects of wildlife immobilization. Sixteen people attended the training, including NWRC staff from Colorado and Utah, as well as a senior animal control officer of the Navajo Nation Fish and Wildlife Department.

Institutional Animal Care and Use Committee (IACUC) Training—In August 2008, the NWRC, along with the U.S. Department of Health and Human Services' Centers for Disease Control and Prevention (CDC) and CSU, co-sponsored the IACUC 101/201 Plus courses in Fort Collins, Colorado. HHS' National Institutes of Health (NIH), Office of Laboratory Animal Welfare conducted the course. This series is designed to offer basic and advanced training for IACUC members, administrative personnel, and research- and animal-care

staffs involved with the care and/or use of animals in research. Course content is in accordance with the Federal Animal Welfare Act, the NIH Guide for the Care and Use of Animals, and the Public Health Service Policy on Humane Care and Use of Laboratory Animals. Participation in the course was high, with 120 people taking the class, including 7 NWRC employees.

Staff Changes

NWRC Announces New Administrative Officer and Ohio Field Station Leader—Joyce Gubler recently became NWRC's new Administrative Officer. Ms. Gubler brings a wealth of experience from her previous positions with WS. Her most recent position was WS' Operational Support Staff Director for Administration. Ms. Gubler's ability to create a bridge between the national and field level perspectives on administrative issues will be a great benefit to NWRC. In her new role, she will be responsible for managing a team of administrative, budget, facilities, and human resources specialists.

Joyce Gubler. *(Photo by: Gail Keirn)*

Travis DeVault. *(Photo by: USDA)*

Dr. Travis DeVault was selected as the new leader of the NWRC field station in Sandusky, Ohio, and the research project "New Technologies to Deter Wildlife from Airports and Aircraft." Dr. DeVault earned his B.A. and M.S. from Indiana State University, and a Ph.D. in Wildlife Science from Purdue University. His research experience includes studying black and turkey vultures to improve existing Bird Avoidance Models (BAM) implemented by the U.S. Air Force Bird/Wildlife Aircraft Strike Hazard (BASH) Team; working with airport officials in Indiana to conduct wildlife hazard assessments at general aviation airports; investigating the impact of wildlife damage to corn and soybeans; and evaluating the impact of ring-billed gull predation on the nesting success of the federally endangered interior least terns. For the past 2 years, Dr. DeVault has worked for NWRC as a research scientist co-located with WS operations in Brewerton, New York. In this position, he has concentrated on conducting research related to developing and evaluating management strategies for double-crested cormorants. Dr. DeVault reported to his new duty station in Sandusky, Ohio, in June 2008.

2007 NWRC Publication Awards

NWRC's Publication Awards Committee selected three journal articles as outstanding research publications for 2007:

Atwood, T. C.; VerCauteren, K. C.; DeLiberto, T. J.; Smith, H. J.; Stevenson, J. S. 2007. Coyotes as sentinels for monitoring bovine tuberculosis prevalence in white-tailed deer. Journal of Wildlife Management 71: 1545-54.

Bynum, K. S.; Eiseman, J. D.; Weaver, G. C.; Yoder, C. A.; Fagerstone, K. A.; Miller, L. 2007. Nicarbazin OvoControl G bait reduces hatchability of eggs laid by resident Canada geese in Oregon. Journal of Wildlife Management 71: 135-43.

Pilon, J.; Loiacono, C.; Okeson, C.; Okeson, D.; Lund, S.; VerCauteren, K.; Rhyan, K.; Miller, L. December 2007. Multiple anti-prion activity generated by a novel vaccine formulation. Neuroscience Letters 429 (2): 161-164.

The article by Todd Atwood and co-authors postulated that coyotes might be useful as a sentinel species for monitoring the movement of bovine tuberculosis across landscapes in Michigan. It is well documented that this disease currently resides in free-ranging white-tailed deer, a major prey item of coyotes, within the study area. Numerous aspects of coyote behavior and spatial ecology were examined in this study, using contemporary methods of resource selection analysis. In addition to documenting the potential of coyotes serving as a sentinel for the prevalence of bTB within landscapes, the findings of the study provide further understanding about coyote spatial ecology and resource utilization in managed forested landscapes. Finally, Atwood and co-workers provide useful suggestions for future research and predictive modeling efforts regarding bTB surveillance programs.

The scientific work by Kimberly Bynum and co-authors is a significant contribution to the literature and is worthy of recognition, in part, because it directly contributed to the EPA registration application for nicarbazin as a reproductive inhibitor for use in Canada geese. In the study by Bynum and co-workers, resident Canada geese were treated with OvoControl G 2,500-ppm nicarbazin bait at 10 field sites in Oregon immediately prior to and during the breeding season to determine the effects on hatchability of eggs laid by treated geese. The authors found that treatment with nicarbazin bait reduced hatchability of eggs laid by resident Canada geese by 36 percent and increased the number of nests with no hatching eggs by 93 percent as compared to control sites. Bynum and co-workers concluded that OvoControl G 2,500-ppm nicarbazin bait could be used as a control tool to reduce the recruitment of goslings into problem resident Canada geese populations. These findings are of paramount importance because expanding populations of resident Canada geese are increasingly resulting in conflicts with humans at golf courses, industrial parks, government sites, and city parks where other damage control methods are restricted. This paper presents data in support of an alternative and effective wildlife damage management tool under these scenarios.

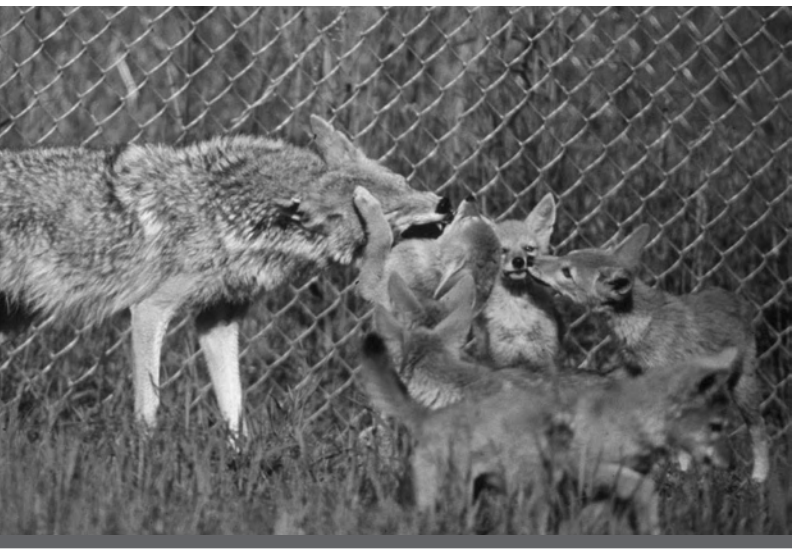
The paper by John Pilon and co-authors was generated in the initial steps to develop a vaccine formulation for chronic wasting disease (CWD), a transmissible disease of wild and domestic cervids. The unique nature of the infectious agent makes the development of a vaccine a daunting task. The authors focused their efforts on a key event, the formation of a proteinase resistant prion. Although

a fully successful vaccine was not developed, the research successfully demonstrated an ability to overcome immune tolerance and generate a subsequent anti-prion effect. Demonstration of the anti-prion effect or the delay in the onset of clinical symptoms or death has been rarely achieved in other studies. The results of this study increase the potential of developing a successful vaccine for the disease.

All three of these publications are excellent examples of the high-quality research being conducted by NWRC scientists.

Supporting Student Research

CSU Undergraduate Research and Creativity Showcase 2008 Award—Brett Coghlan, an employee in the NWRC Wildlife Genetics Laboratory and a CSU Hughes Undergraduate Research Scholar, received an honors award for outstanding performance from the CSU, College of Natural Resources for his poster "Phylogeography of Mountain Beaver (*Aplodontia rufa*)."



Coyotes with pups at Logan, UT, field station. *(Photo by: NWRC)*

Coyote Reproduction Dissertation—Utah State University Ph.D. student Debra Carlson successfully defended her dissertation based on NWRC-funded research. The title of her dissertation is "Reproductive Biology of the Coyote: Integrating Hormones and Behavior." Carlson's work investigated social behavior, endocrine profiles, and vaginal cytology of female coyotes during four breeding seasons. Carlson found that behavioral patterns correlated with the secretion of steroid hormones. Her study included characteristics not previously published for this species and showed how key aspects of reproduction were correlated temporally, emphasizing the importance of an integrated perspective when addressing the reproductive biology of coyotes. The findings of this research provide baseline information for National Environmental Policy Act submissions and have potential implications for reproductive control of coyotes and identification of breeding animals in the field.

Ecology of Jaguars in Brazil Dissertation—Sandra Cavalcanti, a Ph.D. candidate in the Utah State University Department of Wildland Resources, successfully defended her dissertation "Ecology of Jaguars in the Southern Pantanal, Brazil." Cavalcanti's research, which the NWRC supported, investigated the foraging ecology of jaguars living on a cattle ranch in the southern Pantanal of Brazil and documented kill rates, characteristics of prey killed, and patterns of predation. Between October 2001 and April 2004, Cavalcanti captured and monitored 10 jaguars equipped with GPS collars and collected 11,787 GPS locations during the 30-month study. She found prey remains at 415 kill sites and documented 438 prey items. Individual jaguars differed in their selection of prey species. Some had a high proportion of kills consisting of cattle, while others did not. This study provided previously unknown

data on jaguar kill rates, predation patterns, and prey species killed in an area with both native prey and cattle.

Wolf Damage in Wisconsin Thesis—Arion Vandergon, a graduate student at Utah State University, successfully defended his NWRC-sponsored research on predator damage in Wisconsin. The objective of the study was to determine the fate of beef calves on three farms in Minnesota and Wisconsin over a 2-year period. In addition, Vandergon studied predator presence/absence as an indicator of potential depredations and compared two animal monitoring technologies that could be used by researchers and livestock producers. Vandergon attached radio telemetry collars and eartags to beef calves during the spring and summer of 2006 and 2007. During this time, four calves were killed by wolves on the study farms. Contrary to expectations, the wolves did not appear to select the youngest calves. Radio collars and radio eartags were both effective for monitoring of beef calves.

Clemson University Grey Squirrel Contraceptive Study—Two Ph.D. candidates, Murali Pai and Cady Etheredge, in the wildlife and fisheries biology program at Clemson University are evaluating two contraceptive vaccines developed at the NWRC as grey squirrel contraceptives. This research is a collaborative effort among the NWRC, the South Carolina Wildlife Services Program, and the South Carolina Department of Natural Resources.

NWRC Scientists Assist Columbia University—In August 2008, Drs. Will Pitt and Mike Avery of the NWRC Florida and Hawaii field stations, respectively, served as external reviewers of a Columbia University doctoral student paper, "Bird frugivory in agricultural landscapes: lessons for Neotropical psittacine conservation practitioners." The population status of threatened and endangered species of parrots, many of them endemic, on Caribbean islands is a major concern for wildlife managers and conservation biologists. One source of concern in this complex issue is damage to fruit crops caused by some of the endangered parrots. The student's research focuses on the conflict between parrots and citrus production in Dominica. The NWRC scientists' critical review on interactions between birds and agriculture in the new world tropics will assist in evaluating the student's understanding of this complex wildlife management issue prior to the initiation of doctoral research.

Math Bowl Competitions—In April 2008, Dr. Rick Engeman helped organize "Math Bowl" competitions for Fort Collins, Colorado, students in grades 6 through 9. In each Math Bowl competition, four teams of five students each are asked to solve mathematical and some statistical questions. The competitions were enthusiastically received by the audiences of students, parents, and faculty. Events such as this help to increase student and parent interest in the mathematical sciences and motivate students to advance in the discipline at young ages.

NWRC Gives Invasive Species Talk to Elementary School Children—In January 2008, Dr. Richard Engeman gave a presentation on invasive species to elementary school students and teachers. Dr. Engeman discussed the characteristics of invasive species and showed the students some of the many invasive species research topics NWRC is studying. While most of the audience was aware of the ubiquity of rats as one of the most destructive invasive vertebrates in the world, they were surprised to learn about the global damage inflicted by cats, pigs, and goats. Burmese pythons, BTS, and Nile monitor lizards were of particular interest to the students.

Enhancing Information and Communication

Brown tree snake.
(Photo by: Gordon H. Rodda, USGS)

NWRC strives to share its expertise and knowledge with others and help build an understanding of the Federal role in wildlife damage management.

Legislative and Public Affairs—In 2008, NWRC and APHIS Legislative and Public Affairs (LPA) staff responded to roughly 95 media and community requests for information regarding WS research activities. Notable requests included the Discovery Channel, CBS News Radio, *The Washington Post*, Inside Edition, and National Geographic Channel. NWRC and LPA gave tours of the facilities to various groups, including CSU and New Mexico State University wildlife and agriculture students, the International Overhead Line Conference attendees, Texas AgriLife Extension Services ranchers, and the APHIS Advancing Leaders Program.

Library—The NWRC Research Library joined the other APHIS libraries in Riverdale, Maryland, and Fort Collins, Colorado, in purchasing the Electronic Online Systems (EOS) International Web Express library online system this year. The new online system has improved library services with a Web-accessible online catalog of library book, report, and media holdings and a more reliable serials management process. The conversion to the new software required the transfer of thousands of records from the old system. Library personnel added all journal holdings to the new catalog, re-entered checkout information, and identified and corrected transfer errors. The new system user interface is much easier for library patrons to use, and staff is able to navigate and update record information more quickly.

NWRC also moved its library stacks and evaluated all serials, books, and reports for either retention or de-accessioning. Library staff removed from the shelves many journals that are now available through online sources. They also retired duplicate and out-of-date materials and repositioned library holdings to allow for future growth.

The library purchased a subscription to JSTOR, a vendor that provides full-text access to older issues of journals. Employees now have access to the JSTOR Biological Sciences Collection, which contains journals such as Auk, Condor, the Journal of Mammalogy, and the Journal of Wildlife Management.

NWRC library personnel reconfigured and updated wall posters describing the Center's program areas and gathered material for a new poster describing all the supporting services at NWRC. They framed copies of these posters, which now hang outside the Longs Peak conference room where they can be viewed by conference, workshop, and seminar attendees. Library personnel also completed a touch-screen kiosk presentation, now located in the main entrance to the NWRC's Wildlife Science Building. The kiosk describes research at NWRC and contains several multimedia files for enhanced viewing. NWRC's Information Technology group developed a portable version of the kiosk and distributed it to WS personnel.

The NWRC's Information Services Unit staff borrowed, photocopied, or downloaded more than 900 items from other libraries in response to information requests from the WS program and lent 102 items in return. Additionally, staff photocopied nearly 2,000 in-house journal articles, reports, and NWRC-authored reprints for distribution to researchers and WS operations staff. The staff also mailed out more than 1,000 copies each of the NWRC's Annual Accomplishments Report and Publication List. They also distributed more than 14,000 other NWRC or WS information products, including children's activity sheets, factsheets, and information packets.

Web Site—The move of the NWRC Web site to the new APHIS design look has been completed. NWRC staff re-formatted the Center's publication lists from 1989 through 1997 and standardized and uploaded the list to the new Web site. All NWRC-authored reprints for those years were also uploaded and linked. The NWRC 2007 Annual Publication List is complete and links to the full-text of all 2007 publications. NWRC reviewed and added yearly highlights to all NWRC program and project pages. The Center has also made available through the Web site all papers from the NWRC-sponsored Managing Vertebrate Invasive Species conference, in addition to congressional briefing documents describing NWRC research projects. In addition, NWRC added updated product labels to the registration page, produced new genetics pages and a new NWRC Utah field station page, and added Technical Notes and "Solutions through Science" brochures to the publications page. All new NWRC publications added to the Web site are also uploaded to the USDA National Agricultural Library's AgSpace where the full text is available through this portal.

In addition to the NWRC Web site, the NWRC Information Services Unit staff is providing guidance and support in the production of the WS' National Wildlife Disease Program Web site to be launched in 2009.

Archives—The mission of the NWRC Archives/Records Management Unit is to collect, preserve, and make available the research records and materials that document the history of NWRC. To that end, much of the Unit's work in the past year focused on tasks to organize and make accessible historical records. The Unit also highlighted, in exhibits and staff-outreach activities, materials that tell the story of NWRC's research.

The annual NWRC Archives week, from October 3 through 7, 2007, was a time to celebrate the Center's archival records and history. NWRC invited retirees to tour the site facilities and attend a lunch on October 4, with current employees and the WS Deputy Administrator. In addition, retirees had the opportunity to identify historical photographs that previously contained no information. In a letter sent to the archives several days later, one retiree stated "What a beautiful day it turned out to be…".

Hallway exhibit cases provide NWRC the opportunity to show visitors and staff current and past research. An exhibit at the main entrance to the Center's Wildlife Science Building highlights the history of NWRC's telemetry work. Two other exhibit cases throughout the building showcase various traps throughout the years and NWRC's rodent research.

Seminars—The NWRC seminar program offers a valuable forum for the exchange of ideas among Center staff, field station personnel, visiting scientists, and WS operations staff. During 2008, NWRC hosted approximately 13 seminars, including presentations by speakers from various universities and foreign wildlife organizations, NWRC headquarters and field staff, and potential candidates for employment.

Presentations by NWRC scientists and visitors during 2008		
Speaker	**Affiliation**	**Title**
Tommy King	NWRC, Gainesville, FL	Winter and Summer Home Ranges and Core Use Areas of Double-Crested Cormorants Captured Near Aquaculture Facilities in the Southeastern United States
Martin Smith	Bioforsk, Norwegian Institute for Agriculture and Environmental Research	Brown Bears in Norway: Conflict and Conservation and the Role of the Svanhold Research Center
Dr. Fred Bryant	Caesar Kleberg Wildlife Research Institute	Overview of the Caesar Kleberg Wildlife Research Institute
Roger Hollevoet, Joel Brice, Jim Fisher	Delta Waterfowl, USFWS	Predator Management in the Prairie Pothole Region
John Johnston, Tom Primus, Katherine Horak, Bruce Kimball, David Goldade, Toni Piaggio, Melissa Neubaum, Randal Stahl, Jerry Hurley	NWRC, Fort Collins, CO	Development of Chemistry, Biochemistry and Computational Based Tools for Wildlife Damage Management
Charles Eason	Lincoln University, Jefferson City, MO	Developments in Humane Low Residue Vertebrate Pest Control Products
Diana Dwyer, Christi Yoder	NWRC, Fort Collins, CO	Fort Collins Urban Prairie Dogs
George Linz	NWRC, Bismarck, ND	A National Vision for Managing Black Feathered Birds
Nancy Freeman	NWRC, Fort Collins, CO	Taking Care of Those Piles of Files
Lyn Hinds	Commonwealth Scientific and Industrial Research Organization, Australia	Wallaby Fertility Control and Disease Vaccines
Jessica Mahalingappa and Scott Goldman	APHIS International Technical and Regulatory Capacity Building (ITRCB)	ITRCB Overview
Gary Witmer	NWRC, Fort Collins, CO	Invasive Mammals Research Project: Accomplishments FY04–FY08
Alexander Bachmanov	Monell Chemical Senses Center	Taste Preferences and Feeding Behavior: Physiological, Genetic, and Comparative Analyses

NWRC scientists also served as guest lecturers or presented seminars at the request of other agencies and organizations. Examples of these presentations include the following:

Presentations by NWRC scientists as guest lecturers		
Speaker	**Location**	**Title**
Brad Blackwell	Wildlife Damage Management course, Auburn University, School of Forestry and Wildlife, Auburn, AL	Efficacy of Aircraft-Mounted Lighting To Reduce Bird-Aircraft Collisions
Brian Dorr	Mississippi State University, Wildlife and Fisheries Department, Starkville, MS	The National Wildlife Research Center Overview
Richard Engeman	Graduate Statistical Consulting course, CSU, Department of Statistics, Fort Collins, CO	A Unique Statistical Experience
Paul Oesterle	Graduate-Faculty Seminar Series, CSU, Department of Fish, Wildlife and Conservation Biology, Fort Collins, CO	The Role of Swallow Bugs and Cliff Swallows in the Transmission of West Nile Virus
Jeff Root	Epidemiology of Infectious Diseases and Zoonoses class, CSU, Department of Environmental and Radiological Health Sciences, Fort Collins, CO	Epidemiology of Hantaviruses in the New and Old Worlds
Susan Shriner	Wildlife Disease Ecology class, CSU, Department of Fish, Wildlife, and Conservation Biology, Fort Collins, CO	Modeling Disease in Space
Jimmy Taylor	Wildlife Science class, Washington State University, Department of Natural Resources, Pullman, WA	Wildlife Damage Management and the Role of Wildlife Services
Brian Washburn	North Carolina State University, Department of Forestry and Environmental Resources, Raleigh, NC	Use of Satellite Telemetry To Assess Wildlife Hazards To Aviation

Meetings, Workshops, and Conference Presentations

To help promote collaboration and the exchange of scientific information, NWRC scientists often present at, host, or attend national and international scientific meetings. Some of the meetings recently attended or hosted by NWRC scientist include the following:

American Association of Lab Animal Diagnosticians
American Chemical Society 234th National Meeting
American Oil Chemists' National Meeting
American Sheep Industry Association Annual Meeting
Aquaculture America Conference
Association of Zoos and Aquariums Western Regional Conference
Australian Vertebrate Pest Conference 14th Annual Meeting
Bird Strike Committee USA/Canada
Brown Treesnake Technical Working Group Meeting
Catfish Farmers of Arkansas Annual Meeting
European Wildlife Disease Association
First International Conference on the Coqui Frog Conference
Fourth Meeting of Wetlands International Cormorant Research Group
Fourth Pan Pacific Conference on Pesticide Science
Hawaii Conservation Conference
International Association for Great Lakes Research 50th Annual Conference
International Beaver Ecology and Management Conference
International Meeting on Rabies in the Americas
Managing Blackbirds, Starlings, and Corvids Conference
Managing Vertebrate Invasive Species
National Sunflower Association 30th Sunflower Research Forum
Ninth Mountain Lion Workshop
Sixth International Conference on Fertility Control for Wildlife
Third International Symposium on Zoo and Wildlife Disease
Twelfth Wildlife Damage Management Conference
Twenty-Third Vertebrate Pest Conference
United States Animal Health Association 111th Annual Meeting

Publications

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